VOL. 5 NO. 7
April 15, 1980

Energy Research Abstracts

ABSTRACTS 9562-11032

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UNITED STATES DEPARTMENT OF ENERGY

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Volume 5, No. 7
ISSN: 0160-3604
CODEN: ERABDZ
April 15, 1980

ENERGY RESEARCH ABSTRACTS

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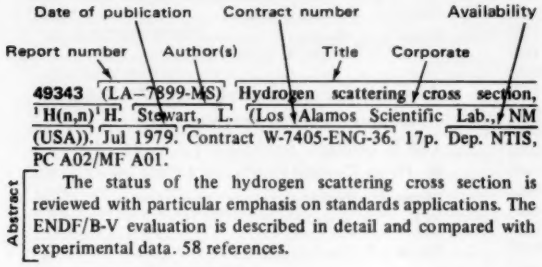
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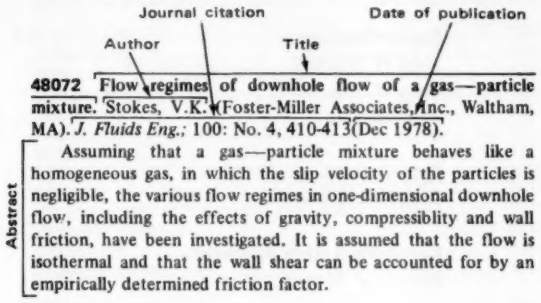
49343 (LA–7899-MS) Hydrogen scattering cross section, $^1H(n,n)^1H$. Stewart, L. (Los Alamos Scientific Lab., NM (USA)). Jul 1979. Contract W-7405-ENG-36. 17p. Dep. NTIS, PC A02/MF A01.
Abstract
The status of the hydrogen scattering cross section is reviewed with particular emphasis on standards applications. The ENDF/B-V evaluation is described in detail and compared with experimental data. 58 references.


Journal citation
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48072 Flow regimes of downhole flow of a gas—particle mixture. Stokes, V.K. (Foster-Miller Associates, Inc., Waltham, MA). J. Fluids Eng.; 100: No. 4, 410-413 (Dec 1978).
Abstract
Assuming that a gas—particle mixture behaves like a homogeneous gas, in which the slip velocity of the particles is negligible, the various flow regimes in one-dimensional downhole flow, including the effects of gravity, compressiblity and wall friction, have been investigated. It is assumed that the flow is isothermal and that the wall shear can be accounted for by an empirically determined friction factor.

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is indexed as:

Los Alamos Scientific Lab., NM (USA)
Advanced laser fusion target fabrication research and development proposal, 4:48249 (LA–7619-P)
Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)
Low temperature physics and engineering. Quarterly progress report, January 1–March 31, 1979, 4:48988 (LA–7848-PR)

•Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Stewart, L., Hydrogen scattering cross section, $^1H(n,n)^1H$, 4:49343 (LA–7899-MS)
Stewart, M.D., *See* McInroy, J.F., 4:49280
Stewart, W., *See* Dean, J.W., 4:48543
Stimson, J., Reproduction, growth, and survival of Enewetak corals, 4:49200 (NVO–0703-1, pp 56-59)

•Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

HYDROGEN 1 TARGET/NEUTRON REACTIONS
Hydrogen scattering cross section, $^1H(n,n)^1H$ (Above 100 keV, review), 4:49343 (LA–7899-MS)
HYDROGEN NITRATES
See NITRIC ACID
HYDROLOGY/RESEARCH PROGRAMS
Inventory of advanced energy technologies and energy conservation research and development: 1976-1978. Volume II. Prepared for the Committee on Science and Technology, U.S. House of Representatives, Ninety-Sixth Congress, 4:48749

•Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

W-7405-ENG-36	**Los Alamos Scientific Lab., NM (USA)**	
	3:49698	LA-tr–78-45
	3:49857	LA–7224T
	3:49863	LA–7235-MS
W-7405-ENG-48	**California Univ., Livermore (USA). Lawrence Livermore Lab.**	
	3:49386	UCRL–52456
	3:49431	UCRL–52405

•Report Number Index

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

9562 (ORNL—5574) **Fossil Energy Program. Quarterly progress report for the period ending June 30, 1979.** (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 433p. Dep. NTIS, PC A19/MF A01.

This quarterly report covers the progress made during the period March 1 through June 30 for the Oak Ridge National Laboratory research and development projects that are carried out in support of the increased utilization of coal and other fossil fuel alternatives to oil and gas as sources of clean energy. These projects are supported by the DOE Divisions of Fossil Fuel Processing, Fossil Fuel Utilization, Fossil Fuel Extraction, Planning and Systems Engineering, Basic Energy Sciences, and Health and Environmental Research, and by the Tennessee Valley Authority and the EPA Office of Research and Development through interagency agreements with the DOE.

9563 (PB—292949) **A Kentucky energy resource utilization program. Semiannual report 1 Jan—30 Jun 78.** (Kentucky Univ., Lexington (USA). Inst. for Mining and Minerals Research). Dec 1978. 77p. NTIS PC A05/MF A01.

This report describes progress on the Kentucky Energy Resource Utilization Program during the six-month period from January 1 to June 30, 1978. The work described is an extension and expansion of the program undertaken by the Institute for Mining and Minerals Research (IMMR) during the 1972-1974 biennium, and further expanded during the 1974-1976 biennium. The IMMR is the prime contractor for research and development to the Kentucky Department of Energy (KDOE). The program is organized into three major functional categories, each with an operating division: Materials, Process Development, and Resources, Recovery and Reclamation. A summary of activities for each division for this reporting period is included in this report.

PROCESSING

REFER ALSO TO CITATION(S) 9602

CARBONIZATION

REFER ALSO TO CITATION(S) 9620

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 9677, 10423

GASIFICATION

REFER ALSO TO CITATION(S) 9562, 9581, 9669, 9741, 9742, 9748, 9765, 9766

9564 (ANL—79-93) **Materials technology for coal-conversion processes. Eighteenth quarterly report, April-June 1979.** (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 70p. Dep. NTIS, PC A04/MF A01.

A 500-h test run, exposing 11 water-cooled refractories to basic slag (B/A = 1.5), was completed. High chromia content and high density again appeared to be significant factors contributing to the corrosion resistance of refractories used for slag containment. A literature review on high-temperature ultrasonic coupling was completed and suggested that studies on long-term (months to years) pressure-coupling stability are needed. Flow-induced acoustic-energy studies (relevant to acoustic leak detection) suggested that a 20% coal-water slurry flowing through an orifice under pressure produces acoustic-energy excitation mainly at frequencies < 65 kHz, and that a better correlation between acoustic rms levels and flow rate is obtained as the differential pressure is increased. Corrosion studies of Type 310 stainless steel at 1000°C with various P/sub O2/ and P/sub S2/ suggested that titanium addition increases the corrosion rate relative to that of commercially available steels. Fluid-bed corrosion studies showed that at temperatures of 800-1000 K addition of salt has no effect on the corrosion behavior of any material examined. Failure analyses were performed on a cyclone nozzle from the Westinghouse Waltz-Mill combined cycle coal-gasification plant and an external cyclone from the Morgantown Energy Technology Center Stirred-bed Gasifier.

9565 (DOE/ET—0061/2) **Coal conversion. 1978 technical report.** (Department of Energy, Washington, DC (USA). Div. of Fossil Fuel Processing). Sep 1979. Contract EX-76-C-01-2297. 194p. Dep. NTIS, PC A09/MF A01.

The United States has more energy available in coal than in petroleum, natural gas, oil shale, and tar sands combined. Nationwide energy shortages, together with the availability of abundant coal reserves, make commercial production of synthetic fuels from coal vital to the Nation's total supply of clean energy. In response to this need, the Division of Fossil Fuel Processing - US Department of Energy is conducting a research, development and demonstration program to provide technology that will permit rapid commercialization of processes for converting coal into products that substitute for those derived from oil and natural gas. These substitute fuels include crude oil, fuel oil and distillates; chemical feedstocks; pipeline quality and fuel gas; and other products such as char that may be useful in energy production.

9566 (DOE/ET—0067/4) **Coal gasification. Quarterly report, October-December 1978.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). Sep 1979. Contract EX-76-C-01-2297. 64p. Dep. NTIS, PC A04/MF A01.

DOE's program for the conversion of coal to gaseous fuels was started by two of its predecessor agencies: the Office of Coal Research (OCR) and ERDA. The US Bureau of Mines, Department of Interior, had previously done research in the 1930's. Both high- and low-Btu gasification processes are being developed. High-Btu gas can be distributed economically to consumers in the same pipeline systems now used to carry natural gas. Low-Btu gas, the cheapest of the gaseous fuels produced from coal, can be used economically only on site, either for electric power generation or by industrial and petrochemical plants. The conversion of coal to high-Btu gas requires a chemical and physical transformation of solid coal. Coals have widely differing chemical and physical properties depending on where they are mined, and are difficult to process. Therefore, to develop the most suitable techniques for gasifying coal, DOE, together with the American Gas Association (AGA), is sponsoring the development of several conversion processes. Although the basic coal-gasification chemical reactions are the same for each process, each of the processes under development have unique characteristics. There are, for example, important differences in reactor configurations and methods of supplying heat for gasification. Moreover, because these processes require high temperatures, because some require high pressures, and because all produce corrosive and chemically-active gases, resistant alloys and new pressure vessels must be developed to obtain reliable performance. A number of the processes for converting coal to high-Btu gas have reached the pilot plant stage. Laboratory research is also continuing in order to develop data for verifying the feasibility of each specific process and for supporting the operation of each plant. Responsibility for designing, constructing, and operating these pilot plants is contracted to individual companies. Each process is described briefly.

9567 (DOE/ET—0069/4) **Coal demonstration plants. Quarterly report, October-December 1978.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). Sep 1979. Contract EX-76-C-01-2298. 64p. Dep. NTIS, PC A04/MF A01.

The Department of Energy's demonstration plant program was started in 1974 by one of the Department of Energy's predecessor agencies: the Office of Coal Research, US Department of the Interior. The objective of the program is to establish the technical and financial feasibility of coal conversion technologies proven during pilot plant testing. Demonstration plants will minimize the technical and economic risks of commercialization by providing a near commercial size plant for testing and production. Thus, DOE is sponsoring the development of a series of demonstration plants, each of which will be a smaller version of commercial plants envisioned for the 1980's. These plants will be wholly integrated, self-sufficient in terms of heat generation, and dependent only on feedstock of coal, water, and air. Under the DOE program, contracts for designing, constructing, and operating the demonstration plants will be awarded through competitive procedures and will be jointly funded. The conceptual design phase will be funded by the government, with the detailed design, procurement, construction, and operating phases being co-funded, 50% from industry and 50% from the government. The cost involved in building and operating a demonstration plant will probably be between $200 million and $500 million, depending on the size of the plant. Individual demonstration plant contracts are described briefly.

9568 (FE—1545-72) **Low-btu gasification of coal for electric power generation. Monthly progress report, November 1-November 30, 1979.** (Combustion Engineering, Inc., Windsor, CT (USA)). 18 Dec 1979. Contract EX-76-C-01-1545. 23p. Dep. NTIS, PC A02/MF A01.

This progress report describes activities performed under the subject contract during November, 1979. Post Run 7 outage items and plant startup checkout to verify acceptability of equipment modifications were completed. Run 8 was initiated and tests 8-1 thru 8-9 were made. Three of the tests were made at MCR (10,000 lb/hr) coal flow rates. Material and energy balances are given for each of the nine November tests, and excluding three tests believed to be non-steady state, had closures averaging +- 5%. As of months end, Run 8 was continuing with 15 to 20 additional tests to be made in December.

9569 (FE—1784-51) **Program to discover materials suitable for service under hostile conditions obtaining in equipment for the gasification of coal and other solid fuels. Quarterly progress report, January 1-March 31, 1979.** Hill, V.L.; Humphreys, A.; Yurkewycz, R.; Bhattacharyya, S; Torok, J.; Vesely, E. Jr.; Diercks, D.R.; Lyle, F.F.; Lindholm, U.S. (Metal Properties Council, Inc., New York (USA)). 26 Jun 1979. Contract EX-76-C-01-1784. 157p. Dep. NTIS, PC A08/MF A01.

This report describes the progress on a program under the direction of the Metal Properties Council, Inc., designed to screen materials for use in such plants with respect to the various unique corrosive environments obtaining therein; and, finally, to provide useful corrosion data as well as reliable information on other properties needed for the design, construction and operation of such plants. This program is sponsored by the US Department of Energy and the Gas Research Institute. The program is being pursued in seven phases. The actual laboratory testing for the first four phases is being carried out at the IIT Research Institute. The testing necessary for Phase V is being conducted at the Southwest Research Institute. The entire program is being monitored by Subcommittee 9 on Materials for the Gasification of Coal of The Metal Properties Council, Inc. A summary of achievements during the first quarter of calendar 1979 is given.

9570 (FE—2416-43(Vol.1)) **Conceptual design of a coal-to-methanol-to-gasoline commercial plant. Volume I. Technical, second interim final report, August 31, 1977-March 1, 1979.** (Badger Plants, Inc., Cambridge, MA (USA)). Mar 1979. Contract EX-76-C-01-2416. 311p. Dep. NTIS, PC A14/MF A01.

This second Interim Final Report presents in five volumes an engineering and economic assessment of the conceptual design for an integrated commercial facility to convert coal-to-methanol-to-gasoline. The process steps involve an oxygen-blown, high-pressure coal gasification technique, followed by a chemical shift reaction, acid gas removal, sulfur recovery, methanol synthesis, methanol conversion using Mobil technology, gas fractionation and HF alkylation. The gasoline product is suitable for direct use in today's automotive engines. It is assumed that a dedicated pipeline will transport the synthetic gasoline from the plant to existing terminal facilities. The conceptual design incorporates current industrial processes throughout the complex with the exception of the coal gasification step and the Mobil Methanol-to-Gasoline conversion process. Various high-pressure gasification processes are currently under pilot development and/or demonstration. The Mobil process has been successfully piloted and scale-up of the data to commercial-size reactors is not considered a problem. The other processes, well-proven in commercial practice, include: Coal and Lime Preparation, Air Separation, Chemical Shift Reaction, Acid Gas Removal, Methanol Synthesis, Cryogenic Recovery of Hydrogen, Sulfur Recovery, Gas Cleanup, Gas Fractionation, and Alkylation. Some equipment items specified in the above processes are larger than any previously built. Fabrication of such equipment were consulted, and they do not foresee any major difficulty in the scale-up of current designs. This project incorporates the latest available technology for environmental control methods.

9571 (FE—2416-43(Vol.2)) **Conceptual design of a coal-to-methanol-to-gasoline commercial plant. Volume II. Commercial plant economic analysis, second interim final report, August 31, 1977-March 1, 1979.** (Badger Plants, Inc., Cambridge, MA (USA)). Mar 1979. Contract EX-76-C-01-2416. 322p. Dep. NTIS, PC A14/MF A01.

This volume presents the economic aspects of the Coal-to-Methanol-to-Gasoline project wherein capital and product costs are addressed. To maintain a common economic datum plane with the Coal-to-Methanol Report issued in February 1978, this second Interim Final Report for the integrated coal-to-methanol-to-gasoline facility also utilizes 1977 dollars as a cost base. The total erected cost of the integrated commercial facility in 1977 dollars is estimated at $3.65 billion which equates to a calculated gasoline price of 51 cents per gallon at the plant gate, or $4.21 per million Btu. Assuming project initiation in mid-1978 (as in the Coal-to-Methanol Interim Final Report of February 1978), the integrated commercial facility could be in full operation by the end of 1986. After one full year of production, the gasoline selling price in January 1988 is calculated at 96.8 cents per gallon at the plant gate, or $7.99 per million Btu. Assuming a realistic project initiation in mid-1980, the commercial plant could be fully erected before the end of 1988. After one year of full production, the January 1990 selling price for gasoline at the plant gate would be $1.09 per gallon, or $9.00 per million Btu. Based upon project initiation in mid-1978, the $3.65 billion will be expended over an eight-year period before a salable product is produced. The inclusion of an annual escalation rate of six percent during this period increases this cost to $5,070,020,000.

9572 (FE—2416-43(Vol.4A)) **Conceptual design of a coal-to-methanol-to-gasoline commercial plant. Volume IV A. Drawings, specifications, and alternate designs, second interim final report, August 31, 1977-March 1, 1979.** (Badger Plants, Inc., Cambridge, MA (USA)). Mar 1979. Contract EX-76-C-01-2416. 504p. Dep. NTIS, PC A22/MF A01.

9573 (FE—2416-43(Vol.4B)) **Conceptual design of a coal-to-methanol-to-gasoline commercial plant. Volume IV B. Drawings, specifications, and alternate designs, second interim final report, August 31, 1977-March 1, 1979.** (Badger Plants, Inc., Cambridge, MA (USA)). Mar 1979. Contract EX-76-C-01-2416. 459p. Dep. NTIS, PC A20/MF A01.

This volume presents information regarding the following alternate coal gasifier concepts: Babcock & Wilcox, Shell-Koppers Gasifier, Winkler Gasifier, and the Saarberg-Otto Gasifier. A bibliography of 267 references is included. (LTN)

9574 (LA—8133-PR) **Catalytic coal conversion support: use of laser flash-pyrolysis for structural analysis. Progress report, May 1-August 31, 1979.** Vanderborgh, N.E.; Verzino, W.J. Jr.; Nichols, B.A. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 47p. Dep. NTIS, PC A04/MF A01.

The major effort during the first quarterly report period was the review of existing technology and project planning. The review phase is now complete and, as anticipated, there is a plethora of current work in coal gasification catalysis. However, very little is being done to elucidate the structural modificatons the coal is undergoing during the preliminary gasification reactions. The project plan for determining the structural changes occurring in coal, using laser pyrolysis are delineated. The pertinent, computer-generated references are appended to this report. Trial heating regimes and laser flash-pyrolysis investigation for structural analysis have commenced. The selection and collection of appropriate catalysts have also begun.

9575 (MIT—2295T9-13) **Computer-aided industrial process design: The ASPEN Project. Third annual report, June 1, 1978 to May 31, 1979.** (Massachusetts Inst. of Tech., Cambridge (USA)). 15 Jun 1979. Contract EX-76-C-01-2295-009. 202p. Dep. NTIS, PC A10/MF A01.

This report contains a description of the models, both conventional and non-conventional, available in the Physical Property System. Most of the models reported in the Eleventh Quarterly Progress Report have been coded. The format of the User's Manual is being finalized. Model subroutines has been designed, coded, and tested for sizing and costing a number of equipment classes, and for estimating total project capital requirements and annual operating expenses. The input processor for the costing and economic evaluation system have been designed and coded. Data have been collected on operating labor rates, fuel, coal and utility costs, and the prices of

24 chemicals that are common raw materials for fossil energy conversion processes. An analysis and comparison of four different regression programs have been made for fitting various vapor-liquid equilibria data. Based upon the results of these tests the design of the data regression system has been nearly completed. It includes a generalized least squares formulation which can take into account errors in all measured variables. It relieves the user of the task of formulating an objective function, and affords a more objective treatment of the data. An evaluation of several available distillation programs was made to determine which would be the most suitable for ASPEN. The implementation and integration of a basic ASPEN system has been accomplished. This means that input data can be processed to produce the Problem Data File and Program File; that the Program File can be compiled and loaded to create the Simulation Program; and that the Simulation Program can read the Problem Data File, execute unit operations models, and converge recycle loops.

9576 **New fuels and advances in combustion technologies.** Chicago, IL; Institute of Gas Technology (1979). 897p. (CONF-790337—). $60.00.

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

The Symposium on New Fuels and advances in Combustion Technologies was held March 26-30, 1979 at New Orleans, Louisiana. It was sponsored by the Institute of Technology, 3424 South State Street, Chicago, Illinois, 60616. The papers deal mainly with novel sources of energy (biomass conversion to methane, use of refinery off gases, alcohols, agricultural and urban wastes, etc.) and with methods of predicting the interchangeability of these and other gases as they are mixed by gas utilities and burned by their customers. The papers have been entered individually into EDB. Five papers had been entered previously from other sources. (LTN)

9577 **Retrofitting industrial furnaces to use low- and medium-Btu gases.** Waibel, R.T. pp 33-44 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

As natural gas becomes unavailable for industrial use many industries will turn to low- and medium-Btu fuel gases as an energy supply for process furnaces. Studies have been done comparing the performance of various low- and medium-Btu gases with that of natural gas using a variety of industrial burner types. The medium-Btu gases from oxygen-blown coal gasifiers give few problems when retrofit to most burners. The low-Btu gases from air-blown gasifiers, however, sometimes experience flame stability (blowoff) problems that can often be alleviated by burner modifications. The low-Btu gases also give lower furnace temperatures and heat transfer rates than natural gas. Pollutant emissions from low- and medium-Btu gases used directly from a gasifier can be much higher than those from natural gas. Cleaning the gases reduces the efficiency of the gasifier by wasting the sensible heat in the fuel but removes the hydrogen sulfide and ammonia, giving pollutant emissions comparable to those of natural gas.

9578 **Void-gas stripping in standpipes.** Knowlton, T.M.; Aquino, C.; Hirsan, I.; Sishtla, C. Chicago, IL; Institute of Gas Technology, Chicago, IL (1979). 45p. (CONF-791108—12).

From 72. AICHE meeting; San Francisco, CA, USA (25 Nov 1979).

During the transfer of solids from one fluidized bed to another via a standpipe, a substantial amount of gas can be transferred with the solids in the interstices. For safety reasons or to prevent contamination or dilution of product gas, it is frequently desired to prevent gas being transferred via a standpipe (from an upper fluidized bed to a lower fluidized bed) from coming into contact with the gas in the bottom bed. To accomplish this, a neutral or noncontaminating gas is usually added to the standpipe to replace, or strip, the normal downcomer gas in the void spaces between the solids. Standpipes are usually operated in one of two modes: the fluidized-bed mode or the packed-bed mode. However, essentially no information exists in the literature on stripping in either standpipe flow mode. It was thought that because of solids and gas backmixing in fluidized beds, the packed-bed regime might be the mode in which interstial standpipe gas could be stripped most efficiently. Therefore, the purposes of this study were to determine the mechanism of stripping in a packed-bed standpipe; determine the effect of several system parameters on stripping requirements; and develop a model to predict the minimum amount of stripping gas required for a particular application. The results of the experiments are described.

LIQUEFACTION

REFER ALSO TO CITATION(S) 9562, 9564, 9565, 9567, 9570, 9571, 9572, 9573, 9575, 9621, 9622, 9623, 9624, 9625, 9626, 9627, 9628, 9629

9579 **(DOE/ET—0068/4) Coal liquefaction. Quarterly report, October-December 1978.** (Department of Energy, Washington, DC (USA). Div. of Coal Conversion). Sep 1979. Contract EX-76-C-01-2297. 61p. Dep. NTIS, PC A04/MF A01.

DOE's program for the conversion of coal to liquid fuels was begun by two of DOE's predecessor agencies: Office of Coal Research (OCR) in 1962, and ERDA. The Bureau of Mines, US Department of the Interior, had started work in the 1930's. Current work is aimed at improved process configurations for both catalytic and noncatalytic processes to provide more attractive processing economics and lower capital investment. The advantage of coal liquefaction is that the entire range of liquid products, especially boiler fuel, distillate fuel oil, and gasoline, can be produced from coal by varying the type of process and operating conditions used in the process. Furthermore, coal-derived liquids have the potential for use as chemical feedstocks. To provide efficient and practical means of utilizing coal resources, DOE is supporting the development of several conversion processes that are currently in the pilot plant stage. Each of these processes are described briefly.

9580 **(FE—2315-43) Refining and upgrading of synfuels from coal and oil shales by advanced catalytic processes. Quarterly report, July-September 1979.** Sullivan, R.F.; O'Rear, D.J. (Chevron Research Co., Richmond, CA (USA)). Oct 1979. Contract EX-76-C-01-2315. 44p. Dep. NTIS, PC A03/MF A01.

Current pilot plant results are presented for processing of H-Coal whole process product derived from Illinois No. 6 coal (Burning Star Mine): first, hydrotreating of the whole oil and, second, extinction recycle hydrocracking of the hydrotreated product. The 250°F+ portion of severely hydrotreated H-Coal whole process product meets the jet fuel specifications for aromatics content, smoke, freeze, and flash points and almost meets the current specification for gravity and end point. The yield of 250°F+ product is 90.4 LV % based on feed. The diesel fuel oxidation stability of 300°F+ hydrotreated products is excellent, even without additives. In an accelerated fouling rate test, the denitrification fouling rate of ICR 106 catalyst was measured. At comparable conditions, the H-Coal whole process product is denitrified to a greater extent than the SRC-II whole process product. Deposits were formed in the preheater of the whole oil hydrotreater, which appear to be from either asphaltenes or soluble iron compounds in the feed. An alumina guard bed ahead of the catalyst successfully removes these contaminants. A large batch of low aromatic, denitrified H-Coal whole process product was prepared for downstream hydrocracking. In this preparation hydrogen was consumed by the oil at roughly 2100 SCF/bbl. The whole product from this hydrotreater was then cracked in an extinction recycle hydrocracker to make a 350°F⁻ product. In this hydrocracking step, hydrogen was consumed by the oil at 800 SCF/bbl.

9581 **(FE—2468-51) Coal conversion comparisons. Final report on Task 002.** Rogers, K.A.; Hill, R.F. (Engineering Societies Commission on Energy, Inc., Washington, DC (USA)). Jul 1979. Contract EF-77-C-01-2468. 99p. Dep. NTIS, PC A05/MF A01.

This ESCOE Report examines technologies for producing synthetic fuels from coal. The conclusion is made that many processes are ready for commercial demonstration but synthetic fuel will be greater than conventional petroleum fuels. All product costs are on a consistent basis using the published ESCOE costing guidelines with both utility and private venture financing. All costs are in mid-1979 dollars. Most other studies report cost for derived products solely on an energy basis, $/million Btu. However, because the actual fuels have different inherent values (a gallon of boiler fuel is not usually worth as much as a gallon of gasoline), an economic comparison method was developed to reflect the value differences of the different fuel products. The ESCOE value method assigns relative values to all products from a multi-product synfuel process. This method incorporates the preferences of the marketplace to arrive at the necessary selling prices for each product. This report also gives process costs on the conventional energy basis. Two methods of financing, using typical utility and private venture returns on investment, are included for all products. The report divides the fourteen conversion processes studied into six groups: solid clean fuel, direct liquefaction, indirect liquefaction, synthetic natural gas, industrial gas, industrial gas, and electric power from a combined cycle-integrated gasifier system. Three of the processes are shown in an alternate mode of operation giving a total of seventeen sets of energy costs. The prediction is made that no major technological advances are expected which will significantly decrease synfuel costs.

9582 **(FE—2893-42) EDS coal liquefaction process development. Phase IV. Monthly technical progress report, October 1-October 31, 1979.** Epperly, W.R. (Exxon Research and Engineering Co., Florham Park, NJ (USA)). Nov 1979. Contract EF-77-A-01-2893. 54p. Dep. NTIS, PC A04/MF A01.

Continuous bottoms recycle operations continued in the 50 pound-per-day Recycle Coal Liquefaction Unit. Yield data were taken at 60 minutes nominal liquefaction residence with Pittsburgh No. 8 bituminous coal (Ireland Mine) on the one •on-per-day Coal

Liquefaction Pilot Plant (CPP). Operations with Ireland mine coal continued to be good. In addition, construction of the bottoms recycle modification was completed on the CLPP and shake-down operations were started. The Ni/Mo-10 catalyst activity maintenance study completed 13 days-on-solvent. A series of experiments on the Continuous Stirred Coking Unit (CSCU) is underway to determine the effect of reduced temperature and feed dilution on coker yields. These runs, as is the FBU study, are being made to test the feasibility of operating the FLEXICOKING prototype unit at reduced temperature to determine the effect of operating near the bogging limit on bed fines retention. Work began on an engineering screening study to evaluate the value of coal liquids products from an EDS plant. A range of product value scenarios are being developed from public sources. These scenarios will be used to determine the effect on net cash flow and process configurations for the coals studied to date. Sensitivities to the Market Flexibility Case RISP were developed to illustrate the effects of various possible government incentives designed to stimulate the development of the synthetic fuels industry.

9583 (FE—3055-T2(Vol.1)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 8. Volume 1. Conceptual commercial plant: summary.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 48p. Dep. NTIS, PC A03/MF A01.

This Deliverable describes a Conceptual Commercial Plant (CCP) using the SRC-II Solvent Refined Coal process for the production of liquid and gaseous hydrocarbon synthetic fuels and by-products from coal. A CCP would charge about 33,500 tons of coal per stream day (tpsd) and be comparable to a 100,000 barrels per stream day (bpsd) petroleum refinery in energy output. The Conceptual Commercial Plant envisioned in this report would produce 56,000 bpsd of fuel oil and 51 million cubic feet per day (MM cfd) of pipeline gas. Other products would include an aromatic naphtha which when further processed would produce a high octane blending stock for gasoline, and light hydrocarbons which could be converted to ethylene (a basic petrochemical building block), providing the basis for a downstream petrochemical complex. The SRC-II plant described here is designed to protect the environment. Recognizing that the SRC-II feedstock is to be a high sulfur bituminous coal which is not suitable for direct firing under current EPA regulations without expensive sulfur removal equipment, this plant has been designed to remove the sulfur contaminant as a by-product. Disposition of other wastes will be accomplished economically in an environmentally acceptable manner. Volume 1 is a general summary of the information presented in the succeeding volumes and touches briefly on feedstocks, products, thermal efficiency, companion plants, future technology, environmental considerations, and projected capital and operating costs.

9584 (FE—3055-T2(Vol.2)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 8. Volume 2. Conceptual commercial plant: plant description.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 439p. Dep. NTIS, PC A19/MF A01.

Volume 2 describes, in concept, an SRC-II coal conversion facility which could be constructed during the 1990's. It also defines the basic elements of configuration, product slate, thermal efficiency and costs. The Conceptual Commercial Plant defined here is based on processing 33,500 tons per stream day of high sulfur Powhatan coal to produce not only the low-sulfur fuel oils and pipeline gas produced by the initial SRC-II facilities but also an aromatic naphtha stream and light hydrocarbon gases. The aromatic naphtha can be upgraded to produce a high octane blending stock and the light hydrocarbon gases can be upgraded to ethylene, a basic raw material for the petrochemical industry. This volume describes a grass-roots facility located on an unspecified site, since an exact location cannot be defined. Detailed descriptive information on the engineering design of the Conceptual Commercial Plant is provided. It includes process flow sheets, block diagrams and tabulated data on charge coal, products, operating conditions and equipment lists. Licensors' and manufacturers' names are used in this volume for the purpose of identification of the type of process, an item of equipment or as a source of information or material. It is not meant to imply that these are the only acceptable sources that will be available.

9585 (FE—3055-T2(Vol.3)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 8. Volume 3. Conceptual commercial plant: supporting reports.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 143p. Dep. NTIS, PC A07/MF A01.

Volume 3 contains an independent engineering evaluation of the design of the Conceptual Commercial Plant prepared by Scientific Design Company, Inc. This evaluation includes a process design review, a review of estimating procedures, and recommendations for process improvement. This volume also contains letters from process licensors and manufacturers of high technology equipment commenting on availability and applicability of processes or equipment of special nature as applied in the Conceptual Commercial Plant design. This volume contains a technical report prepared by Gulf Science and Technology Company showing how process and utility integration of the Conceptual Commercial Plant with possible downstream processing units provides potential savings for all the process operations. Finally, this volume contains engineering judgments and evaluations by a variety of engineering organizations. Not all these evaluations are in agreement. The differences now evident are expected to be resolved in the course of normal design engineering.

9586 (FE—3055-T2(Vol.4)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 8. Volume 4. Conceptual commercial plant: advanced process and technology.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 3p. Dep. NTIS, PC A02/MF A01.

The SRC-II process has evolved from many years of research and development on solvent refining of coal. It produces high yields of liquid and gaseous fuels that could reduce the nation's dependence on imported petroleum. The fuel products are enviromentally clean and the liquid products can be converted to transportation fuels using technology that has been developed in pilot plant operations. Gulf scientists and engineers working in the field of coal liquefaction have conceived a number of promising ideas presently embodied in the R & D programs for improving the SRC-II process. Expected potential benefits include reduced costs, improved operability and increased feedstock flexibility. On the basis of work completed to date and planned, commercial plants constructed in the 1990's could embody numerous significant advances compared to present designs. Such evolutionary developments would follow precedents demonstrated by catalytic cracking, alkylation and other petroleum refining processes. The work described in this volume has been to forecast and evaluate possible advances in SRC-II designs that might be expected by the mid-1990's. Concepts and data employed in this evaluation are Gulf proprietary.

9587 (FE—3055-T2(Vol.5)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 8. Volume 5. Conceptual commercial plant: economic analysis.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 190p. Dep. NTIS, PC A09/MF A01.

The SRC-II Conceptual Commercial Plant (CCP) is designed to process 33,333 tons of coal per day, and yield approximately 100,000 barrels per day of fuel oil and fuel-oil-equivalent product (Btu basis). For the base case analysis, all products from the SRC-II plant were assumed to be sold at the same price per million Btu's. In actual practice, some lighter products will probably sell at a premium over their fuels value because of their greater utility as a chemical feedstock. Key assumptions specified by DOE for the base case and key financial and operating characteristics assumed are given. The calculated base case SRC-II price (expressed in 1978 dollars) required to meet the DOE-specified parameters is $22.55/bbl ($3.76/MMBtu). In 1988 dollars at the time of plant start-up the price is $40.45/bbl ($6.74/MMBtu). The derived SRC-II price is most sensitive to thermal efficiency, followed by plant capacity, capital investment and coal prices: a 1% increase in thermal efficiency would permit a reduction of 1% in the price; a 10% increase in capacity would permit a reduction of 6.4% in the price; a 10% reduction in capital would permit a 4.4% reduction in price; and a 10% increase in coal cost would result in a 4% increase in product price. The potential ethane and propane production of 1.9 billion pounds per year would carry a significant price premium over fuel value.

9588 (FE—3055-T3(Vol.1)) **SRC-II Demonstration Project. Phase zero, task number 15: deliverable number 12. Volume 1. Plan and estimated cost for Phases I, II and III: management plan summary.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 25p. Dep. NTIS, PC A02/MF A01.

This document summarizes the Project Management Plan, costs and schedule for the SRC-II Demonstration Project. It provides a brief summary of technical aspects, the management plan, management control systems, costs, and economic considerations applicable to the Project. Complete details on these subjects are contained in Deliverable No. 12, Plan and Estimated Costs for Phases I, II, and III, Volumes 2 and 3, Project Management Plan and Project Baseline Plans. The Pittsburg & Midway Coal Mining Co. (P & M), a wholly owned subsidiary of the Gulf Oil Corporation, is committed to the successful conduct of this Project in accordance with the terms and conditions of contract DE-AC05-780R03055.

9589 (FE—3055-T3(Vol.2)) **SRC-II Demonstration Project. Phase zero, task number 15: deliverable number 12. Volume 2. Plan and estimated cost for Phases I, II and III: project management plan.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 103p. Dep. NTIS, PC A06/MF A01.

The Project Management Plan (PMP) describes procedures The Pittsburg & Midway Coal Mining Co. (P & M), (a wholly owned subsidiary of the Gulf Oil Corporation acting through Gulf

Mineral Resources Co. [GMRC]), will use to manage the design, construction and operation of the SRC-II Demonstration Plant to produce liquid products using the Solvent Refined Coal Process known as SRC-II. P & M has administrative responsibility for the Project; however, Gulf Oil Corporation (Gulf) will support all facets of the Project. The PMP is part of Deliverable No. 12, Plan and Estimated Costs for Phases I, II, and III which has been prepared in three volumes: Volume 1 is the Management Plan Summary, Volume 2 is the Project Management Plan and includes the Technical and Commercial Considerations (Appendix A to the PMP) and Volume 3 is Project Baseline Plans (Appendix B to the PMP).

9590 (FE—3055-T3(Vol.3)) **SRC-II Demonstration Project. Phase zero, task number 15: deliverable number 12. Volume 3, Appendix B. Plan and estimated cost for Phases I, II and III: project baseline plans.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 268p. Dep. NTIS, PC A12/MF A01.

This volume contains the integrated workscope, schedule, and cost baselines for the SRC-II Demonstration Project developed in parallel with the Phase Zero Conceptual Design effort by The Pittsburg & Midway Coal Mining Co. (P and M). This volume contains a restatement of the Project objectives, a description of major planning guidelines, and Project baselines. In addition, it contains a list of documents recommended by P & M for delivery in Phase I and projected funding requirements for the Demonstration Project. The baselines reflect P & M's best estimate of the work required to achieve completion of mechanical construction by December 1983 and the associated costs for the Project. The baselines represent the operational planning which P & M will implement as the prime contractor to the Department of Energy. Volume 3 has been separated from the PMP to permit flexibility in updating the Project baseline. Updating will occur as the uncertainties and design problems are resolved during evolution of the Project.

9591 (IS—4717) **Alloy evaluation for fossil fuel process plants (liquefaction). Annual report October 1, 1978-September 30, 1979.** Woods, C.M.; Scott, T.E. (Ames Lab., IA (USA)). Nov 1979. Contract W-7405-ENG-82. 52p. Dep. NTIS, PC A04/MF A01.

Room temperature mechanical properties were determined for A387-74A-Gr.22-Cl.2 steel after various environmental exposures. Exposure conditions include 168 hours at 500 or 800°F in a coal slurry with 4000 psig hydrogen pressure, 1000 hours at 800°F in 4000 psig argon, or 856 hours at 800°F in a coal slurry with 4000 psig hydrogen pressure. Comparison of ambient condition tensile tests of the exposed samples with base property data revealed that no degradation of ambient temperature mechanical properties occurred. Microstructural examination of samples from all exposure conditions run to data showed no dramatic changes with the exception of the formation of a multilayer scale on the surface of samples exposed to the coal slurry environment. Point source x-ray fluorescence and electron microprobe analyses were carried out on these layers along with the parent metal. The relative Fe, Cr, Mo, Mn, S, and Si concentrations were determined and a profile plotted. Scanning electron micrographs were made of the fracture surfaces of unexposed smooth-bar and notched-bar tensile samples and compared to micrographs of like samples exposed for 856 hours in a coal slurry at 800°F in 4000 psig H_2 gas. Fracture surfaces of samples exposed to the slurry exhibited considerably larger voids than those of unexposed samples. Cross sectional area measurements of specimens exposed to a coal slurry environment for 856 hours showed inward growth of scale with subsequent loss of sample diameter.

9592 **Production of distillate fuels by SRC-II.** Jackson, D.M.; Schmid, B.K. (Gulf Mineral Resources Co., Denver, CO). pp 167-179 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

The SRC-II technology for production of low-sulfur distillates and light hydrocarbons has evolved to the point where large-scale demonstration can be considered. Gulf is completing, under contract to DOE, a preliminary evaluation of engineering design and other activities preparatory to a demonstration plant program. The principal objectives of the program are to: (1) verify technical feasibility of the SRC-II process in full-scale equipment, (2) integrate the supporting processes into an overall liquefaction plant, (3) make production quantities of products for testing, (4) develop appropriate systems and equipment for controlling unique environmental, health, and safety factors, and (5) provide a firm basis for estimating capital and operating costs for future commercial plants. The demonstration plant is being designed primarily for conversion of coal into low-sulfur distillate fuel oils for direct utility use. Future commercial facilities offer the economies of scale for recovery of light hydrocarbons and more selective applications of liquid products. SRC-II fuel oil is characterized by low-sulfur content, low viscosity, and low pour point. The major question involving combustion concerns its relatively high nitrogen content. Several burning test programs have been carried out to confirm that SRC-II fuel oil could be successfully used in power plants while controlling emissions. The most significant was a full-scale test in a Consolidated Edison Company power plant in New York City. NO operating problems were encountered; no deposits were observed; particulate emissions were low. NO/sub x/ emissions, although higher than No. 6 fuel oil, were lower than would be expected. NO/sub x/ formation was reduced by staged combustion to a level less than the proposed EPA standard.

9593 **Emission characteristics of alternative liquid fuels.** Heap, M.P.; England, G.C.; Pershing, D.W. (Energy and Environmental Research Corp., Irvine, CA). pp 207-224 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

This paper utilizes experimental information generated in two combustors to discuss the combustion characteristics of coal and shale derived alternative liquid fuels. Compared to conventional petroleum derived liquid fuels alternative liquid fuels have a high fuel bound nitrogen content which could cause an increase in emissions of nitric oxide if appropriate control techniques are not applied. This paper is mainly concerned with the use of alternative fuels in boilers and furnaces and particularly with the control of pollutant emissions by the application of staged combustion techniques. Fuels have been burned in the absence of molecular nitrogen to assess fuel nitrogen conversion to nitric oxide. Results are presented showing the influence of liquid dropsize on nitric oxide emissions. Emissions under staged combustion conditions are correlated with fuel nitrogen volatility. Whenever possible the paper compares results obtained with alternative liquid fuels with those obtained with conventional petroleum derived fuels.

9594 **Combustion of coal derived liquids fuels.** Cohn, A. (Electric Power Research Inst., Palo Alto, CA); De Corso, S.M.; Stein, T.R. pp 246-286 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

As part of the EPRI program on the use of coal-derived liquid fuels in combustion turbines, a range of coal liquids have been identified from the leading processes. Comparative tests in combustion turbine burners have been carried out with twelve coal liquids and No. 2 distillate oil; ten coal liquid fuels were fuels evaluated on half-scale combustor test rig and two fuels were evaluated full scale. Smoke, NO/sub x/, metal temperature effects, also flame radiation, CO, UCH and post-test combustor cleanliness were evaluated. Smoke emission and burner wall temperature will increase with these fuels, when compared to No. 2 fuel. SRC-I light organic liquid and the lighter H-coal distillate appear to be acceptable to present machines (they were lowest in aromaticity). In these tests fuels ignited readily and burned stably with no significant coking. Fuel bound nitrogen content in the coal liquids is converted into exhaust NO/sub x/. The trends follow projections made from computer modeling and tests of oil artificially doped to increased nitrogen content. In all other respects, the fuels were handled acceptably by standard turbine laboratory fuel forwarding systems and combustors.

PROPERTIES

REFER ALSO TO CITATION(S) 9568, 9600, 9621, 9622, 9623

9595 (FE—2030-13) **Characteristics of American coals in relation to their conversion into clean energy fuels. Quarterly technical progress report, July-September 1978.** Spackman, W.; Davis A.; Walker, P.L.; Lovell, H.L.; Vastola, F.J.; Given, P.H.; Suhr, N.H.; Jenkins, R.G. (Pennsylvania State Univ., University Park (USA). Coal Research Section). May 1979. Contract EX-76-C-01-2030. 83p. Dep. NTIS, PC A05/MF A01.

Certain important aspects of the chemical and physical composition of American lignite coals are being characterized. Differential scanning calorimetry and thermogravimetric analysis were used to study the interaction between oxygen and seventeen coal chars (40 x 100 mesh) at 100°C. The same techniques were used to investigate briefly the interaction between air and a highly caking coal at selected isothermal temperatures in the range 100 to 275°C.

9596 **Microporosity and micromineralogy of vitrinite in a bituminous coal.** Lin, J.S.; Hendricks, R.W.; Harris, L.A.; Yust, C.S. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *J. Appl. Crystallogr.;* **11**: 621-625(1978).

Small-angle X-ray scattering (SAXS) and transmission electron microscopy (TEM) have been used to study the microporosity and micromineralogy of vitrinite in a high-volatile bituminous coal (Illinois No. 6). Sections were selected from samples that contained representative amounts of vitrinite. Micropores and fine minerals with sizes ranging between 10 and 1000 A were observed. The

minerals, primarily silicates, were heterogeneously distributed in layers parallel to the bedding plane of the coal. The radii of gyration, surface area, volume fraction, and size distribution of micropores, mesopores, and fine-size minerals were obtained from an analysis of the SAXS curves. The total volume fraction of these components was determined from the integrated intensity to be 0.09 +- 0.02 cm^3 cm^{-3}. The size distributions were found to be trimodal with peaks at 30, 100, and 220 A. These peaks are associated with micropores, microminerals and mesopores respectively. The specific surfaces associated with each peak are 140 +- 20, 3 +- 1, and 10 +- 3 m^2g^{-1}, respectively, while the corresponding volume fractions are 0.004 +- 0.001, 0.026 +- 0.005, and 0.056 +- 0.018 cm^3 cm^{-3} respectively. Comparison of the results from SAXS with those from TEM showed good agreement. 5 figures.

9597 Analysis directory of Canadian commercial coals, Supplement No. 3. Tibbetts, T.E.; Montgomery, W.J.; Faurschou, D.K. Ottawa, Canada; Minister of Supply and Services Canada (1978). 86p. (CANMET—79-7(Suppl.3)). CANMET Publications Office, 555 Booth St., Ottawa, Ontario $4.80.

Chemical and physical analyses of thermal and metallurgical coals currently produced by mines in Nova Scotia, New Brunswick, Saskatchewan, Alberta and British Columbia are reported. The evaluations are part of a continuing CANMET project to monitor Canadian commercial coals to assist marketing and resource assessment activities. The coals were sampled by personnel of the Energy Research Labs. Most of the sampling was done during 1976 and 1977. Generally, the samples represent production on a specific day of both mine run and prepared coals sampled independently by CANMET staff at operating mines, coal washeries and delivery points. Coals are identified by the operator and name of mine, seam coalfield, and location. Information is arranged by province and is intended to provide a ready indication of the quality of commercially available Canadian coals. As such, this document complements the coal industry statistics available in other federal and provincial reports.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 10588

9598 (EPRI-FP—1172) **Monitoring the fixed FGD sludge landfill, Conesville, OH, Phase 1. Final report.** Hupe, D.W.; Shoemaker, S.H. (Baker (Michael), Jr., Inc., Beaver, PA (USA)). Sep 1979. 159p. Dep. NTIS, PC A08/MF A01.

Stabilized flue gas desulfurization sludge, known as Poz-O-Tec, is being landfilled at the Conesville Power Station of the Columbus and Southern Ohio Electric Company. This is the first full-scale application of the IU Conversion Systems, Inc. fixation process for treating FGD sludge. This study has consisted of the background information review and geohydrologic investigations necessary to formulate a long term monitoring program which will determine if full-scale application of the IUCS process (1) reflects laboratory and pilot scale results; (2) provides environmentally acceptable disposal methods; (3) causes operating problems; and (4) meets current and anticipated regulatory agency requirements. Well monitoring to date has indicated that either the Poz-O-Tec or an adjacent emergency sludge retention pond is responsible for levels of conductivity, and concentrations of calcium, total dissolved solids, sulfate, and magnesium which are in excess of recommended drinking water standards. Additional monitoring is needed to accurately define the source.

9599 (IS—4720) **Advanced research and technology: direct utilization-recovery of minerals from coal fly ash. Technical progress report, 1 October 1978-30 September 1979.** Burnet, G.; Murtha, M. (Ames Lab., IA (USA)). Jan 1980. Contract W-7405-ENG-82. 33p. Dep. NTIS, PC A03/MF A01.

Research focused on technical development of promising methods for recovering minerals from power plant fly ash. Development of the high-temperature (HiChlor) gas chlorination process and refinement and definition of the recovery steps of extraction and desilication for the lime-soda sinter process were emphasized. A preliminary design and cost estimate for commercialization of the HiChlor process and a proposal for a process development unit for scale-up of the lime-soda sinter process were prepared. Both physical and chemical beneficiation techniques to upgrade the iron content of the magnetic fly ash were tested; chemical beneficiation using high-temperature NaOH leaching was found to be the most effective method. Pretreatment for each of the processes includes magnetic separation of coal fly ash. Bituminous coal fly ashes contain magnetic iron oxide particles which can be removed by magnetic separation. The magnetic material consists primarily of iron oxides, with small amounts of silica and alumina. Removal of additional silica and alumina will give a product which can be used for steel production. Physical investigations included careful study of internal structure of fly ash particles. Fly ash samples were separated for a range of electromagnetic power settings and the fractions were analyzed for size determinations, chemical compositions, and morphological contents. Chemical analyses showed that, for the nonmagnetic fly ash fractions, the silica and iron contents are independent of size, and that the alumina content is highest in the smaller particles.

9600 (LA—7831-PR) **Trace element characterization of coal wastes. Third annual progress report, October 1, 1977-September 30, 1978.** Wewerka, E.M.; Williams, J.M.; Wangen, L.E.; Bertino, J.P.; Wanek, P.L.; Olsen, J.D.; Thode, E.F.; Wagner, P. (Los Alamos Scientific Lab., NM (USA)). Jun 1979. Contract W-7405-ENG-36. 93p. (EPA—600/7-79-144). Dep. NTIS, PC A05/MF A01.

In 1978, we performed laboratory experiments to investigate the efficacy of several control options for treating coal wastes at the preparation plant or during disposal. Our research revealed that calcining is one of the more effective and permanent means of treating high-sulfur coal wastes before disposal to decrease, quite dramatically, the release of environmentally undesirable pollutants into the drainages from disposal sites. Another promising control method is codisposal of the coal wastes with lime or limestone to neutralize the acid drainage and retain soluble aqueous contaminants within the waste site. Other experiments have examined the feasibility of using natural sealants, such as clays, soils, calcite, and cements, to isolate the disposal site from its immediate environment. The various tradeoffs for these control options are discussed in terms of contaminant reduction, complexity, permanency, and cost. We have begun an assessment of coal preparation wastes from the Appalachian region. Based on the work we have done on refuse from a single plant, it is clear that coal wastes containing a low percentage of pyrite plant, it is clear that coal wastes containing a low percentage of pyrite (< 1 %) generate worrisome amounts of acid drainage. Our experimental results show that the trace elements of environmental concern in the leachates from these low-sulfur wastes are aluminum, manganese, iron, nickel, and copper when their concentrations are in excess of the Environmental Protection Agency's recommended Minimum Acute Toxicity Effluent (MATE) values.

9601 (PB—292501) **Coal humic substances for the treatment of wastewater from stack gas scrubbers, coal conversion plants, and other coal utilization facilities. Completion report.** Manahan, S.E. (Missouri Univ., Rolla (USA). Dept. of Chemistry). 27 Dec 1978. Contract DI-14-34-0001-8027. 40p. NTIS PC A03/MF A01.

Most processes for the conversion of coal to liquid or gaseous fuels, retorting of oil shale, or extraction of oil from tar sands produce relatively large quantities of by-product wastewater. Coal humic substance is a complex organic material prepared by the partial oxidation of coal. This report deals with the uses of coal humic substances for wastewater treatment. The first section is a review of humic substances and their applications to wastewater treatment. The second portion deals with laboratory studies of coal humic substances used for wastewater treatment. The removal of radiolabelled organic compounds from wastewater is described. The interaction of coal humic substances and fly ash is also discussed. Certain types of fly ash are possible sources of base for the preparation of coal humates from coal humic acid. The interaction of coal humic acid with fly ash is compared to that between fly ash and salicylic acid, a low molecular weight analog of one of the major structural entities in coal humic substances.

9602 (PB—294338) **Assessment of coal conversion wastewaters: characterization and preliminary biotreatability. Report for November 1976-May 1978.** Singer, P.C.; Pfaender, F.K.; Chinchilli, J.; Maciorowski, A.F.; Lamb, J.C. III. (North Carolina Univ., Chapel Hill (USA). Dept. of Environmental Sciences and Engineering). Sep 1978. 116p. NTIS, PC A06/MF A01.

The report gives results of the first phase of a project to assess the environmental impact of coal conversion wastewaters and to evaluate, by bench-scale tests, alternative treatment methods. Characteristics of coal conversion wastewaters were obtained from the literature and from information gathered during visits to facilities for coal conversion process development. For all these wastewaters, about 60-80% of total organic carbon is phenolic. Remaining organic material includes, nitrogen-containing aromatics, oxygen- and sulfur-containing heterocyclics, polynuclear aromatic hydrocarbons, and simple aliphatic acids. To test treatment methods, especially biological treatability, on these wastewaters, a synthetic wastewater was formulated which includes 28 organic compounds, inorganic nutrients, and pH buffering additives. For each class of compounds in real wastewaters, one or more representatives are in the synthetic wastewater at the appropriate mean concentrations. Experiments are underway using the synthetic wastewater at quarter strength in four 25-liter biological treatment units. These units are to test biodegradability as a function of retention time and produce acclimated microorganisms for use in respirometric studies.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 10519, 10596, 10681

9603 **Final environmental statement. Proposed development of coal resources in west-central Colorado.** Washington, DC; Bureau of Land Management (1979). 457p. (NP—24207(Vol.1)).

The proposed actions are the review and consideration for approval of six mining and reclamation plans to mine federal and private coal on existing leases in west-central Colorado. This environmental statement is developed in two parts: (1) a two-level analysis of regional impacts (aggregate impacts of the six proposed actions and cumulative impacts of coal- and non-coal-related development) and (2) site-specific analyses of the six proposed actions. Annual production for the proposed actions would total 1.53 million tons by 1980, 7.63 million tons by 1985, and 10.54 million tons by 1990. Combined with existing mining expected to continue through 1990, a total of 15.56 million tons would be produced annually by that date. The proposed actions would not cause the regional air quality to deteriorate; however, within and at the boundaries of some mines, the Class II PSD increments and Colorado air quality standards for total suspended particulates would be exceeded. Surface subsidence would cause some alteration of the existing topography on approximately 3,920 acres and may cause significant local impacts to water resources in the Mount Gunnison and Cottonwood Creek areas. Fifteen other items are summarized.

9604 (PB—292570) **Coal surface mining in New Mexico.** (New Mexico Governor's Task Force Committee on Coal Surface Mining, Santa Fe (USA)). 10 Jun 1975. 33p. NTIS PC A03/MF A01.

The potential impact on New Mexico of increased surface mining is assessed. The questions that are addressed are: How will increased surface mining affect New Mexico, and how can the state control and regulate this industry for the long-term benefit of New Mexico and its people.

9605 **Final environmental statement. Proposed development of coal resources in west-central Colorado.** Washington, DC; Bureau of Land Management (1979). 539p. (NP—24207(Vol.2)).

The final environmental impact statements for four coal mines in Colorado are included in this volume. (LTN)

9606 **Final environmental statement. Proposed development of coal resources in west-central Colorado.** Washington, DC; Bureau of Land Management (1979). 388p. (NP—24207(Vol.3)).

This volume contains comments and responses to letters received on the basis of the draft environmental impact statement, 16 appendices and 16 maps. (LTN)

9607 **Draft environmental statement: regional analysis. Northern Powder River basin coal, Montana.** Helena, Montana; Montana Dept. of State Lands (1979). 317p. (NP—24208).

In compliance with the National Environmental Policy Act of 1969, this draft statement is an analysis of environmental impacts from current coal development proposals on existing leases in the northern Powder River basin of Montana. Three mining and reclamation plans (mine plans) have been proposed for Federal and State approval; two electric power-generating units have been proposed for Federal approval. The mine plans include 3828 acres of existing Federal coal leases and 540 acres of private coal leases. A total of 7400 acres of Federal and private land would be required for the mines, related facilities, and rights-of-way. Volume I of this statement analyzes cumulative impacts of the proposed developments, considered in the context of other existing and projected coal-related development in the area. Three levels of coal production are analyzed: low, intermediate (most probable), and high levels. Volume II is a site-specific analysis of the proposed Pearl mine.

RESERVES AND EXPLORATION

9608 (BM-RI—8406) **Geology, mining, and methane content of the Freeport and Kittanning coalbeds in Indiana and surrounding counties, Pa.** Puglio, D.G.; Iannacchione, A.T. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Coal Research Center). 1979. 35p. Bureau of Mines, Washington, DC.

This Bureau of Mines study covers 25 underground mines that were active in the Upper and Lower Freeport and Lower Kittanning coalbeds in 1976. The coal ranges from low to medium volatile in rank; its primary use is for steam generation. The methane gas content of three core samples of the Lower Kittanning coalbed was estimated by the direct method. A sample from a depth of 320 feet contained 0.5 cu cm of gas per gram, at 620 feet there was 0.8 cu cm of gas per gram, and at 1060 feet there were 11 cu cm of gas per gram. In the study area, the seven mines with the highest methane emissions per day are generally the deepest and largest producers. The mines that have low methane emissions are small drift mines working under shallow cover and have relatively low production rates. Of the five coalbed horizons that occur in the Freeport and Kittanning Formations, only the Upper and Lower Freeport and the Lower Kittanning are of economic importance. Underground and surface mining of these coalbeds occurs in areas possessing minable thicknesses that are greater than 28 inches in thickness and that are generally greater than 200 acres in area. Local and regional variation in coal thickness is the norm for the Freeport and Kittanning coalbeds, and is the consequence of depositional controls exerted in the deltaic environment. Complex rock joint systems occur in each quadrangle in the study area and roughly correspond to three fundamental joint systems. Structural and depositional discontinuities have affected mining and development in the economically important coalbeds.To date, 10 separate thrust faults have been reported. When such faults are encountered underground, poor roof conditions can be associated with these features.

9609 (BM-RI—8407) **Methane content and geology of the Hartshorne coalbed in Haskell and Le Flore Counties, Okla.** Iannacchione, A.T.; Puglio, D.G. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Coal Research Center). 1979. 14p. Bureau of Mines, Washington, DC.

The Bureau of Mines developed data on the methane content of the Hartshorne coalbed, Haskell and Le Flore Counties, Okla. The methane content is calculated to be between 1.1 and 1.5 trillion cubic feet, based on an estimate of total coal in place of 2.4 to 3.2 billion short tons. Methane increases with depth, but the rate of increase decreases with greater depths. Degasification in advance of mining is recommended for all mines operating at depths greater than 500 feet to reduce hazards and methane explosions, decrease mine ventilation costs, and conserve the natural gas that would be otherwise wasted. The purpose of this study is to establish a scientific basis for planning the degasification that will be essential for mining the coal safely.

MINING

REFER ALSO TO CITATION(S) 9597, 9603, 9604, 9605, 9606, 9607, 10508

9610 (BM-RI—8399) **Long-term rock noise plotting techniques.** Repsher, R.C.; Black, D.J. (Bureau of Mines, Denver, CO (USA). Denver Mining Research Center). 1979. 10p. Bureau of Mines, Washington, DC.

Intermittent mining in the slope section at Dutch Creek No. 1 mine, Carbondale, Colo., of the Mid-Continent Coal and Coke Co. has resulted in erratic and minimal rock noise data, which, in turn, has necessitated a change in the method used to plot daily mine noise in order to be useful to the researchers at the mine. Daily and weekly cumulative plots of rock noise under these conditions have not shown significant stress changes as clearly as bimonthly or longer noise rate plots. Hence, longer term cumulative rock noise plots, as described in this Bureau of Mines report, have been added to the data analysis at Dutch Creek No. 1 mine, and have been shown to delineate unique areas of rock noise activity more clearly than shorter term plots. The longer term plots should aid in the detection and delineation of potential failure areas, when used in conjunction with other proven forms of data analysis.

9611 (BM-RI—8400) **Correction factors for low-velocity airflow measurements in mines.** Thimons, E.D.; Maksimovic, S.D.; Kissell, F.N. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Mining and Safety Research Center). 1979. 15p. Bureau of Mines, Pittsburgh, PA.

The Bureau of Mines conducted in-mine tests to determine correction factors applicable to low-velocity airflows (below 150 fpm) measured by the smoke cloud, vane anemometer, and oil of wintergreen tracer gas techniques. The average correction factors found for these methods of measurement were lower than those reported in the literature for use with higher velocity measurements. All tests measured airflows with controlled average velocities ranging from 50 to 100 fpm. Correction factors averaged about 0.75 for readings taken by the centerline smoke cloud method, remotely controlled and stick-held centerline anemometer, and split traverse stick-held anemometer. For hand-held centerline anemometer and oil of wintergreen tracer gas readings, correction factors averaged about 0.67. Since special anemometers are needed to measure airflows in this low-velocity range, and since proper calibration of these anemometers is difficult and expensive, the use of anemometers for low-velocity measurement is impractical. On the other hand, smoke and oil of wintergreen give results as consistent as those obtained with specially calibrated, low-velocity anemometers. Furthermore, they are easy to use and inexpensive.

9612 (DOE/EIA—0008/2(78)) **Energy information report to Congress. Quarterly report: second quarter 1978.** (Department of

Energy, Washington, DC (USA). Energy Information Administration). Oct 1978. 81p. Dep. NTIS, PC A05/MF A01.

Report gives quarterly statistics on the supply of and demand for coal, natural gas, petroleum and petroleum products, nuclear energy, and total electric power in the United States. A narrative summary of highlights and trends is included. Supply and demand categories for each fuel type include total US production, consumption by type of consumer use and product type, sales by type of purchaser, stocks at major consumer plants and in bulk storage or underground storage, imports by country of origin and by type of product, and exports by country of destination and by product. For nuclear energy, plant status and capacity are reported, as are domestic uranium requirements and commitments, requirements for uranium enrichment services, and inventories of nuclear fuel. Also tabulated are data on resources consumed for total electrical energy generated (by electric utilities), price and rate information about electricity, and information about exploration and drilling for crude oil and natural gas. 55 tables.

9613 (DOE/EIA—0128/4Q(78)) **Production of coal, bituminous and lignite, 1978 per week.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1978. 46p. Dep. NTIS, PC A03/MF A01.

Weekly report shows estimated US production of bituminous coal and lignite in short tons. Data are also available individually for twenty-six coal producing states, and cover the week, the month, and the year-to-date, as well as the previous year. Data are presented for the last quarter of 1978.

9614 (PB—292333) **Dynamic simulation of coal mine electrical power systems. Completion report.** Morley, L.A.; Trutt, F.C.; Thomas, S.A. (Pennsylvania State Univ., University Park (USA). Dept. of Mineral Engineering). 30 Jan 1978. 141p. NTIS PC A07/MF A01.

Two mine electrical system simulations are presented. The first is a batch-processed procedure capable of modeling a single mining machine consisting of a number of motors operating under various loads. These loads are the mechanical torque loads present at the motor shaft. The second simulation is a more flexible tool for modeling entire mine electrical power systems. Detailed analyses of bus voltages, transmissionline power flows, and machine behavior are possible. This simulation operates interactively and the power system is configured as the user responds to program generated questions and requests. Development of the theory behind the programming, as well as detailed explanations of the models, is presented. Examples are provided to demonstrate simulation capabilities.

9615 (PB—297834) **A statistical evaluation of the effects of environmental and operational parameters on the production of coal mine dust. Final report.** Andria, G.D.; Saltsman, R.D. (Bituminous Coal Research, Inc., Monroeville, PA (USA)). May 1978. Contract J0275007. 78p. NTIS PC A05/MF A01.

This report comprises a statistical analysis of respirable coal mine dust data from six previous Bureau of Mines investigations. Relevant data items were cataloged, assembled, and procedures were formulated suitable for the evaluation. A multilinear regression analysis that related dust concentrations measured in a mine to other mine parameters was selected for the procedure. Five variables that significantly affect dust concentrations in the return behind the brattice are the distance from the face to the return brattice, the return airflow, the production rate, and the water consumption rate; these variables describe 85 percent of the total variation in the return dust concentration. Results at the miner and jack-setter locations were somewhat less conclusive because only 17 percent of the variation in dust at the miner could be resolved and only 48 percent of the variation at the jack-setter location could be explained.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 9617

9616 (AD-A—070221) **An analysis of the issues affecting the coal slurry pipeline movement. Master's thesis.** Williams, F.A. (Naval Postgraduate School, Monterey, CA (USA)). Mar 1979. 112p. NTIS PC A06/MF A01.

This thesis contains an examination, analysis, and commentary upon the prospective use of slurry pipelines as a supplemental means of coal transportation in support of the announced United States goal to double coal production by 1985. It examines the rudiments of the slurry industry and traces its growth to the present. A thorough review of the technical, legal, and political aspects of the controversial issues influencing the construction and operations of long distance coal pipelines is presented along with a commentary on the cases for and against slurries. Finally, sets of both general and specific conclusions are offered regarding the potential use of the coal pipelines.

COMBUSTION

REFER ALSO TO CITATION(S) 9578, 9592, 9671, 9672, 9680, 10465

9617 (CONF-7811145—(Exc.)) **VGB technical meeting on coal furnaces, 1978.** (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (Germany, F.R.)). 1978. 107p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

From VGB technical meeting on coal furnaces; Essen, F.R. Germany (3 Nov 1978).

Six papers from the proceedings of the VGB technical meeting on coal furnaces 1978 have been entered individually into the data base. (LTN)

9618 (COO—4740-7) **700, 100, and 20 hp combustion test facilities. Quarterly activity report, July 2, 1979-September 30, 1979, third quarter.** (Management and Technical Services Co., Clairton, PA (USA)). 1979. Contract EW-78-C-02-4740. 8p. Dep. NTIS, PC A02/MF A01.

Objective of the DOE/PETC 700 H.P. Combustion Test Facility (CTF) is to show the feasibility of coal-oil slurry combustion as a retrofit technology. The coal-oil mixture (COM) parametric combustion test program in the CTF was completed successfully for 30, 40, and 50% coal-oil concentrations; plugging in the nozzles at 50% COM and burner nozzle wear were among the problems. Progress on the 100 and 20 H.P. units is also reported. (DLC)

9619 **Direct use of lignite for power generation.** Selle, S.J.; Honea, F.I.; Sondreal, E.A. (Dept. of Energy, Grand Forks, ND). pp 287-321 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

Lignite, as a direct fuel for steam-electric power plants, is used chiefly in those areas of the country with close proximity to reserves. Power production for use in North and South Dakota and portions of Minnesota and Montana depends significantly on the lignite reserves of the Northern Great Plains Province. Lignite from the Gulf Province will continue to play an ever increasing role in meeting the needs of utilities in Texas and other Gulf Coast states. In this presentation, a description of lignite reserves and characteristics is followed by a description of the historical background and current trends for lignite use as a direct power plant fuel. Major operating considerations for lignite as a power plant fuel, such as ash fouling and slagging, boiler design, and emission controls are discussed. Research efforts to predict and improve operations on lignite are described.

MARKETING AND ECONOMICS

9620 (DOE/EIA—0122(77)) **Coke producers in the United States in 1977. Energy data report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Oct 1978. 10p. Dep. NTIS, PC A02/MF A01.

This annual publication contains a list of names and addresses of companies operating oven coke plants and beehive coke plants in the United States, as of December 31 of the previous year. The plants are listed alphabetically by State. One of the tables gives the location of oven coke plants, classification or type of ownership (furnace or merchant), major uses of coke (captive or commercial sales), and twenty-one specific coal chemical materials produced. Another gives beehive coke plant locations, major uses of coke, and type of ovens at each plant (machine drawn or hand drawn). This report was previously published by the Bureau of Mines in the Mineral Industries Surveys series. 2 tables.

9621 (FE—3055-T1(Vol.1)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 1. Market assessment: market opportunity for SRC-II fuel oil.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 674p. Dep. NTIS, PC A99/MF A01.

SRC-II fuel oil is potentially attractive as a fuel for generating electric power for the following reasons: (1) SRC-II fuel oil, at presently estimated costs, would be expected to be economically competitive with replacing oil in existing oil-fired boilers, fueling new oil-fired boilers in East Coast urban locations, and fueling new combined cycle combustion turbines at today's level of technology and new advanced combined cycle combustion turbines at forecasted levels of technology regardless of utility location. (2) At the projected estimate of SRC-II fuel oil costs, SRC-II fuel oil would be expected to be economically competitive in Eastern urban areas compared to other means of coal utilization for electric power generation. This includes boilers with flue gas desulfurization, with on-site or off-site sludge disposal, and coal gasification integrated with advanced combined cycle combustion turbines. (3) The SRC-II

fuel oil alternatives would have the additional advantage of being an environmentally clean method of generation which would not present waste control problems at the site of electric power generation. This is especially important for the electric power generation demands of the populous East Coast region. When the above considerations are combined in a utility systems analysis with the higher reliability of simple-to-operate and maintain oil-fired generating equipment, the SRC-II fuel oil alternatives emerge having the potential to provide a lower revenue requirement to the utility system, when used in conjunction with nuclear base load power generation, by providing electric power in a broad range of load classification and for regions in addition to East Coast urban areas. The dominant economic theme is the inability of the direct use of coal alternatives to offset their higher capital and operating costs with the lower fuel cost of coal, compared to the estimated cost of SRC-II fuel oil.

9622 (FE—3055-T1(Vol.2)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 2. Market assessment: combustion test program, supporting results.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 581p. Dep. NTIS, PC A25/MF A01.

A number of combustion tests of SRC-II fuel oil have been conducted with financial support from Gulf, EPRI, and other organizations. Reports from the tests included in this volume provide information about the technical feasibility of SRC-II fuel oil use in various markets. This section provides technical abstracts and highlights of each test and offers some interpretive comments to point out issues, place items in context, and offer alternative solutions to problems. A table indicates the various boiler and burner-designs and flame configurations for emissions suppression in each test. The success of these designs in suppressing emissions from SRC-II fuel oil combustion is indicated by the resulting NO/sub x/ concentrations, fuel-NO yields, smoke numbers and particulates concentrations. Comments about each test are summarized.

9623 (FE—3055-T1(Vol.3)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 3. Market assessment: utilization in electric utility industry, supporting results.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 244p. Dep. NTIS, PC A11/MF A01.

These studies, made with the involvement of Consolidated Edison of New York, Baltimore Gas and Electric, Boston Edison Company, and Florida Power Corporation, indicate SRC-II fuel oil could be a significant and economically competitive fuel for electric power generation in the populous east coast region of the United States. These studies included a range of applications: replacing oil in existing oil-fired boilers, fueling new oil-fired boilers, new combined cycle combustion turbines at today's level of technology, and new advanced combined cycle combustion turbines at forecasted levels of technology. In all cases, using the projected estimate of SRC-II fuel oil costs, SRC-II fuel oil was indicated as a viable alternative when compared to other means of coal utilization, which includes boilers with flue gas desulfurization (FGD) with on-site or off-site sludge disposal and coal gasification integrated with advanced combined cycle combustion turbines. In almost all cases, the dominant economic theme is the inability of the direct use of coal alternatives to offset the higher capital cost of these alternatives with the lower fuel cost of coal compared to the estimated costs of SRC-II fuel oil. In addition to the economic and financial advantages, the SRC-II fuel oil alternatives are judged as having the additional potential of being a simple and efficient, environmentally clean oil-fired method of generation, which furthermore would not present waste control problems at the site of electric power generation.

9624 (FE—3055-T1(Vol.4)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 4. Market assessment: industrial boiler fuel, supporting results.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 254p. Dep. NTIS, PC A12/MF A01.

Section 4 of Volume 1, The Market Opportunity for SRC-II Fuel Oil As Industrial Boiler Fuels, required economic and market-related inputs in order to assess the potential for SRC-II distillate as industrial boiler fuel. General industrial steam boiler economics were developed in Section 4 of Volume 1 as a function of the type of boiler and type of fuel, and conclusions were made on the extent of the SRC-II fuel oil market as industrial boiler fuel. This volume provides outside supporting studies based on important site-specific cases, one each in the manufacturing industry and the process industry. A study providing data on the industrial boiler population and market-related characteristics of the boiler population, as well as an interpretive review of previous existing industrial boiler fuel studies, is also presented. These data were used to estimate the size of the market once the SRC-II fuel oil opportunity had been delineated by the economics studies.

9625 (FE—3055-T1(Vol.5)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 5. Market assessment: direct fuel application, transportation and industry.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 105p. Dep. NTIS, PC A06/MF A01.

This volume contains two reports on direct applications of SRC-II fuel oil other than in electric power generation or industrial steam production. The first report deals with two categories, as follows: (1) medium speed diesel engines for locomotives, marine propulsion, standby power, pipelines, oil drilling rigs, off-highway trucks, industrial power, and flood water pumping; and (2) transportation-type gas turbines for off-highway trucks and construction machinery, highway trucks and buses, workboats, pipelines, electrical generation. The second report deals with direct-fired industrial heaters of two types: (1) kilns; reverberatory furnaces; rotary, flash, and spray dryers; blast furnaces; annealling and heat treating furnaces where the combustion gases are in direct contact with the products being manufactured. (2) Process heaters in which oils or liquid chemicals are heated in tubes inside a furnace, much as water is heated in the tubes of a boiler. The quantities of fuel consumed in the United States in these applications, principally No. 2 diesel fuel and No. 2 fuel oil, are estimated. SRC-II fuel oil shows promise for direct substitution in significant quantities in some of the industrial processes (perhaps with low-NO/sub x/ burners) as gas and petroleum fuel oil become scarce. Substitution in the diesel engines and transportation-type gas turbines might require engine adjustments and/or modifications, and possibly some fuel upgrading (additives and/or hydrogenation). Test work is needed; is under consideration; and in some instances is under way to explore the match between fuels and equipment.

9626 (FE—3055-T1(Vol.6)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 6. Market assessment: market opportunities for methane from SRC-II.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 86p. Dep. NTIS, PC A05/MF A01.

The SRC-II process can convert coal into a product spectrum ranging from boiler fuel to pipeline quality gas. Depending on the exact process configuration and which portion of the product is used as plant fuel, a 30,000 ton per day commercial SRC-II plant could produce from 50 to 200 billion Btu per day of pipeline quality gas. This would represent from 18 to 75 billion cubic feet (BCF) per year of natural gas supply. The original plan for the demonstration facility being proposed called for location of the plant in reasonable proximity to the operations of Consolidated Natural Gas Company (CNG). The SRC-II Demonstration Plant would process about 6700 tons of coal per stream day. This would result in about 15 BCF per year of pipeline quality gas supply being potentially available to CNG in the mid-1980's. Assuming the demonstration proves successful, a five-fold plant expansion is envisioned as possible in the late 1980's. In order to explore the potential for pipeline quality gas from SRC-II, P and M requested that Consolidated Natural Gas Company examine its potential need for future coal-derived pipeline quality gas. P and M also requested that CNG comment on the relative economic position of Synthetic Natural Gas (SNG) from SRC-II in comparison to that from other potential pipeline quality gas technologies. CNG examined its future gas requirements and supply balance. The results indicated that coal-derived pipeline quality gas is an attractive CNG supply option and that the timing of the proposed SRC-II project is consistent with CNG's need for supplemental gas. As a result, CNG expressed an interest in acquiring the SNG to be produced from the SRC-II Demonstration Plant.

9627 (FE—3055-T1(Vol.7)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 7. Market assessment: market opportunity for ethylene, BTX, and fuel cell feedstock from SRC-II.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 272p. Dep. NTIS, PC A12/MF A01.

Volume 7 contains studies on the conversion of the ethane and propane from a conceptual commercial plant to ethylene. Three separate studies on ethylene are included covering economics, ethane/propane supply and demand, and the disposition of the ethylene and derivative chemicals in the market. Also contained in Volume 7 is a study on converting SRC-II naphtha to benzene, toluene, and xylene (BTX), instead of conversion to gasoline as discussed in Volume 8. As a consequence of extracting BTX, a quantity of highly paraffinic naphtha would remain. The paraffinic naphtha would be an attractive feedstock for conversion to ethylene or for projected future fuel cell generation of electric power. A separate part of Volume 7 discusses future fuel cell technology and the potential for application of this by-product from BTX extraction.

9628 (FE—3055-T1(Vol.8)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 8. Market assessment: transportation fuels from SRC-II upgrading.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 154p. Dep. NTIS, PC A08/MF A01.

Converting SRC-II naphtha to gasoline could be accomplished at no net change in the value or cost of the SRC-II naphtha,

because the added value that would result from upgrading to gasoline would be offset by the estimated cost of upgrading. Between 13,000 B/D and 22,000 B/D, including SRC-II butanes, of high octane (clear) gasoline blend stock could be produced by pretreating and reforming SRC-II naphtha. The production range would result from the boiling range of the naphtha feedstock to the conversion plant and from the coal feedstock to the SRC-II plant. The additional cost of upgrading is estimated to be about $5/B, depending on the above feedstock factors, but as mentioned above, this is offset by the higher value of the gasoline blend stock. The additional capital investment required is estimated to be about $74 million. The high clear (unleaded) octane of the SRC-II gasoline blend stock would result in greater yields of gasoline from crude petroleum, when blended at a petroleum refinery, because of a reduced refinery reformer severity requirement to meet the same gasoline pool octane requirement. The economics of this case and the others in this volume are based on conservative 1990 petroleum product value forecasts. These forecasts were made prior to recent oil price escalation and increasing emphasis by crude suppliers on marketing heavier crudes. The value of naphtha, in particular, has increased. This implies further evaluation of the economic potential for SRC-II naphtha would be more favorable, especially in the years beyond 1990 as petroleum becomes increasingly scarce and expensive.

9629 (FE—3055-T1(Vol.9)) **SRC-II Demonstration Project. Phase zero, task number 3: deliverable number 9. Volume 9. Market assessment: petroleum markets outlook, supporting reports.** (Pittsburgh and Midway Coal Mining Co., Denver, CO (USA)). 31 Jul 1979. Contract ET-78-C-01-3055. 183p. Dep. NTIS, PC A09/MF A01.

This report was prepared for Pittsburg and Midway Coal Mining Co. to project the world petroleum outlook to 2000, with emphasis on the US situation, but within the perspective of world energy and economic activity. In fact, the oil outlook - supply, demand, and most important, price - is derived by our system of balancing economic growth with energy supply, demand, and price. A single set of projections is adopted as the most probable as of June 1979, but the outlook may change as it has been changing over the past decade: In the early 1970s, we anticipated a rising real price for oil and considered that the true market price in 1973 was at least $5 a barrel (FOB Saudi marker crude) but acknowledged that how much above $5 a barrel was indeterminate. As it turned out, the market price was $10 a barrel. In 1974-75, we projected no real increase in the price of oil to 2000. In 1976-78, we projected that the real price would escalate at 3% per year to 2000. In this June 1979 outlook, we project rising real prices at 5% to 6% per year on a higher base for 1979. A major cause of this revision is the permanent loss of MMBD of production in Iran, or so the situation there is viewed. These changes have been caused principally by disappointments (except in Mexico) in exploration results. This in turn encourages some members of OPEC to constrain production still further. The last and most serious event is the dramatic decrease in Iranian production and the clear indication that 2 MMBD of the reduction is permanent.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 9615

PETROLEUM

RESERVES

9630 **Channel sands and petroleum potential of Monterey deep-sea fan, California.** Wilde, P. (Univ. of California, Berkeley); Normark, W.R.; Chase, T.E. *Am. Assoc. Pet. Geol. Bull.;* **62**: No. 6, 967-983(Jun 1978).

The possibility of substantial petroleum resources in deep water adjacent to the continents in areas of hemipelagic sedimentation has been suggested by numerous authors. One such area adjacent to the United States is the continental rise off California between 33 and 40° N latitude. The rise covers 200,000 sq km and consists of three major submarine fans, the Arguello, Monterey, and Delgada, with sediment thicknesses up to 3 km in water depths of 3,000 to 4,500 m. The fans are composed primarily of continental debris carried down submarine canyons and deposited on the fan through a system of branching and meandering submarine valleys and channels. During the development of the fan, the active channelway shifts periodically in response to locally increased gradients, producing abandoned channels. The coarser sediment naturally confined to the channel becomes covered, after abandonment, by finer grained material because of slumping, reworking, and subsequent fan deposition. Such channels, after sufficient burial, would make excellent stratigraphic traps for hydrocarbons, especially if abandonment occurs on the upper fan where the grain size of channel-fill sediments is coarser and the channel width and relief are greater. On the Monterey fan, potential stratigraphic traps would be seaward of the mouths of the Monterey-Carmel, Ascension, and Pioneer Canyons as shown by subbottom profiling. The proximity of such potential reserves to the United States and to existing refineries and markets in coastal areas makes buried channels on large deep-sea fans such as the Monterey fan particularly attractive prospects. 7 figures, 3 tables.

GEOLOGY AND EXPLORATION

9631 (BNL—50908) **Geology of oil and gas in western Siberia.** Premuzic, E.T.; Gaffney, J.S. (eds.). (Brookhaven National Lab., Upton, NY (USA)). Dec 1978. Translation source information not available. 165p. Dep. NTIS, PC A08/MF A01.

An extensive report of the studies carried out in the Western-Siberian Plateau is presented. Paleogeographic, hyrogeological and geochemical data are reviewed from a mechanistic point of view directed at distribution, magnitude and time of petroleum and gas formation and accumulation. Particular attention is given to the current Soviet methodology in search and prospecting for gas and oil deposits.

9632 (DOE/RA—0044) **Analysis of exploration, development and production activity on Federal outer continental shelf leases.** Gribbin, J.A.; Kaitz, G.M.; Edwards, S.W.; Erickson, K.W. (Department of Energy, Washington, DC (USA). Office of Leasing Policy Development). Dec 1979. 152p. Dep. NTIS, PC A08/MF A01.

The recently passed Outer Continental Shelf Lands Act Amendments of 1978 reconfirmed Congress' desire to ensure that persons holding Federal Outer Continental Shelf (OCS) leases act in a diligent manner to explore and develop the resources on these leases. Since the Secretary of Energy is responsible for issuing regulations that establish diligence requirements for operations on Federal leases, the Leasing Policy Development Office (LPDO) examined the actual history of operations on all Federal OCS leases. This report presents the findings of that examination. The primary objective of the analysis was to determine and to describe the actual record of exploration, development, and production activity on Federal OCS leases. The analysis was designed also to identify factors that influence the rate of this activity.

DRILLING AND PRODUCTION

REFER ALSO TO CITATION(S) 9612, 9638

9633 (BETC/RI—79/3) **Effect of temperature and sulfonate concentration on calcium tolerance.** Meister, M.J.; Wilson, C.A.; Collins, A.G. (Department of Energy, Bartlesville, OK (USA). Bartlesville Energy Technology Center). Jan 1980. 16p. Dep. NTIS, PC A02/MF A01.

Calcium tolerance of these sulfonates increases as temperature or sulfonate concentration increases. Above 2 wt % sulfonate, tolerance increases as the logarithm of sulfonate concentration. The fraction of sulfonate (CB 450 at 30° C) neutralized by calcium is not the same in the precipitate as in the supernatant solution. In either case, the rest of the sulfonate is neutralized by sodium. These fractions also vary as the total sulfonate concentration changes and as precipitation proceeds. Before much precipitation has occured, the precipitate fraction reaches a minimum and solution viscosity a corresponding maximum.

9634 (DOE/EIA—0105/6-8(78)) **Availability of heavy fuel oils by sulfur levels. Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 57p. Dep. NTIS, PC A04/MF A01.

This monthly report includes a narrative analysis of the status of the United States' total new supply of heavy fuel oils, with an emphasis on sulfur levels. Tables detail refinery production, stocks, and imports of residual fuel oil and No. 4 fuel oil by sulfur content. All data except stock figures are reported on a monthly and on a year-to-date basis; stock data are reported on an end-of-current-month basis. Units of measure are thousands of barrels. Stocks held at refineries and bulk terminals and refinery production are given by Petroleum Administration for Defense (PAD) and Refinery Districts. Imports are given by PAD Districts, by country of origin, and by importing State. Waterborne movements from PAD District III to other Districts are detailed for the most recent month only. The December issue repeats the seven major tables with final data in all categories for the previous calendar year. 13 tables.

9635 (NTIS/PS—79/0529) **Petroleum exploration, production, and recovery methods (citations from the NTIS data base). Report for 1964-March 1979.** Hundemann, A.S. (National Technical Informa-

tion Service, Springfield, VA (USA)). Jun 1979. 230p. NTIS PC N01/MF N01.

Various methods of oil recovery such as water flooding, gas flooding, steam flooding, and thermal recovery methods are discussed in this bibliography of Federally-funded research. Also included are methods used in prospecting for oil and predicting oil recovery; production processes and costs; and mining and petroleum laws of various countries. Offshore drilling and recovery is not included. (This updated bibliography contains 219 abstracts, 60 of which are new entries to the previous edition.)

9636 (NTIS/PS—79/0530) **Petroleum recovery. Volume 3. Reservoir engineering and recovery methods, April 1977-February 1978 (citations from the Engineering Index data base). Report for April 1977-February 1978.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 217p. NTIS PC N01/MF N01.

Thermal recovery methods and well stimulation using waterflooding, steam injection, gas injection, and fluid injection techniques are discussed in this bibliography covering worldwide research. Topic areas cover fire flooding, caustic water flooding, miscible displacement, microemulsion flooding, polymer flooding, carbon dioxide miscible flooding, control of water mobility using polymers, and heat loss calculations. Reservoir modeling and simulation studies and studies pertaining to well logging, core analysis, and well perforation are included. A few abstracts discuss techniques of determining residual oil saturation, predicting oil recoverability, and monitoring the degree of flooding. (This updated bibliography contains 211 abstracts, none of which are new entries to the previous edition.)

9637 (NTIS/PS—79/0531) **Petroleum recovery. Volume 4. Reservoir engineering and recovery methods. March 1978-March 1979 (citations from the Engineering Index data base). Report for March 1978-1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 202p. NTIS PC N01/MF N01.

Thermal recovery methods and well stimulation using waterflooding, steam injection, gas injection, and fluid injection techniques are discussed in this bibliography covering worldwide research. Topic areas cover fire flooding, caustic water flooding, miscible displacement, microemulsion flooding, polymer flooding, carbon dioxide miscible flooding, control of water mobility using polymers, and heat loss calculations. Reservoir modeling and simulation studies and studies pertaining to well logging, core analysis, and well perforation are included. A few abstracts discuss techniques of determining residual oil saturation, predicting oil recoverability, and monitoring the degree of flooding. (This updated bibliography contains 196 abstracts, all of which are new entries to the previous edition.)

PROCESSING

REFER ALSO TO CITATION(S) 9639, 9643, 9644

PRODUCTS AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 9642

9638 (DOE/EIA—0108(77)) **Crude petroleum, petroleum products, and natural gas liquids: 1977. Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 8 Dec 1978. 36p. Dep. NTIS, PC A03/MF A01.

This annual report contains an analysis of final US data for the previous year's crude petroleum, petroleum products, and natural gas liquids supply and demand situation. Thirty-six tables and one map support the analysis with statistics on production, stocks at refineries and gas processing plants, imports, exports, and domestic demand for twenty finished petroleum products, including demand for petroleum used in refining and processing. Crude oil and lease condensate production, producing oil wells, and crude oil value at the wellhead are reported for each State. Movements of crude oil and petroleum productss by tanker and barge, and movements of petroleum products by pipeline are given for transportation between Petroleum Administration for Defense (PAD) Districts. Monthly and annual data on total US imports of crude oil and finished petroleum products into each PAD District are itemized by product and by country of origin. Exports of US petroleum are listed both by country of destination and by product from each PAD District. Refinergy inputs and outputs are detailed by product for each month of the year, as are refinery yield data. Some tables present annual totals from the previous year for comparative purposes. Wholesale price indexes for crude petroleum and refined petroleum products are given for each month (1967 = 100). A narrative summary presents highlights and trends supported by the data.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 9629, 9634, 9638, 10508

9639 (DOE/EIA—0012/6-9(78)) **Petroleum market shares. Report on sales of refined petroleum products.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jun 1978. 80p. Dep. NTIS, PCA 05/MF A01.

Monthly report shows estimated data collected in survey questionnaires submitted to the DOE by selected samples of refiners and independent marketers of refined petroleum products. Refiner sales distribution and market shares for petroleum products to ultimate consumers and to independent marketers by major and other refiners are given. Estimates of volume of sales and market shares of nonbranded independent marketers, branded independent marketers, and refiner marketers are also given. Survey methods and major findings are described in the narrative section. A glossary of terms is included.

9640 (DOE/EIA—0102/24) **Assessment of potential US petroleum supply shortfalls, 1978. Analysis memorandum AM/IA/78-06.** Butler, D. (Department of Energy, Washington, DC (USA). Energy Information Administration). 2 Jun 1978. 17p. Dep. NTIS, PC A02/MF A01.

The purpose of this Analysis Memorandum is to provide an assessment of potential US petroleum supply shortfalls for the year 1978. The assessment is based upon the mid-range (Projection Series C) supply and demand projections provided in the Energy Information Administration 1977 Annual Report to Congress, Volume II. A total of five disruption scenarios (25% OAPEC embargo, 50% OAPEC embargo, Persian Gulf closure, OPEC embargo, and targeted OPEC embargo) for the year 1978 was simulated using the Petroleum Allocation (PAL) model. The expected supply shortfalls to the United States resulting from each of these cases are summarized.

9641 (DOE/EIA—0109/6(78)) **Energy data reports: a facsimile report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jun 1978. 50p. Dep. NTIS, PC A03/MF A01.

Data are presented on supply, demand, and stocks of crude oil, petroleum products, and natural gas liquids, for the months of June and July 1978. Refinery inputs, imports, transport, etc., are also included. (DLC)

9642 (DOE/EIA—0113(77)) **Sales of fuel oil and kerosene in 1977. Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 21p. Dep. NTIS, PC A02/MF A01.

This annual publication shows sales of distillate fuel oils, residual fuel oils, and kerosene (excluding jet fuel) in the most recent year available and in the previous year. Sales data are given for each State and each Petroleum Administration for Defense (PAD) District. Summary tables cover a five year peroid and give end-use data for each fuel. End uses include heating, industrial use, oil company use, railroads, vessel bunkering use, military use, and electric utility company use. Import and export data are provided for selected fuels for the current and previous year. A narrative section covers trends and highlights. 15 tables, 3 figures.

9643 (DOE/EIA—0116/2Q(78)) **Supply, demand, and stocks of all oils by PAD Districts and imports into the United States, by country. Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 12p. Dep. NTIS, PC A02/MF A01.

Data for the most recent quarter are given for the total supply, demand, and stocks of all oils, of petroleum products, of crude oils, of natural gas liquids, and of unfinished oils for the United States. Data aggregate by PAD (Petroleum Administration for Defense) District for the most recent quarter of the current year. Petroleum products include motor gasoline, aviation gasoline, jet engine fuels, ethane, liquefied gases, kerosene, distillate fuel oil, residual fuel oil, petrochemical feedstocks, naphthas, lubricants, wax, coke, asphalt, and other products. Also given is the percentage of refinery yields based on crude and net unfinished oil rerun. Imports of petroleum products and of crude oil into the United States are shown by country and by continent. Separate data are given for imports from OPEC (Organization of Petroleum Exporting Countries). Data are reported in barrels per day. A map at the end of the report indicates US PAD Districts. 5 tables.

9644 (DOE/EIA—0134/5(78)) **Supply, demand, and stocks of all oils by PAD Districts and imports into the United States, by country. Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). May 1978. 24p. Dep. NTIS, PC A02/MF A01.

Data for the most recent quarter are given for the total supply, demand, and stocks of all oils, of petroleum products, of

crude oils, of natural gas liquids, and of unfinished oils for the United States. Data aggregate by PAD (Petroleum Administration for Defense) District for the most recent quarter of the current year. Petroleum products include motor gasoline, aviation gasoline, jet engine fuels, ethane, liquefied gases, kerosene, distillate fuel oil, residual fuel oil, petrochemical feedstocks, naphthas, lubricants, wax, coke, asphalt, and other products. Also given is the percentage of refinery yields based on crude and net unfinished oil rerun. Imports of petroleum products and of crude oil into the United States are shown by country and by continent. Separate data are given for imports from OPEC (Organization of Petroleum Exporting Countries). Data are reported in a map at the end of the report indicating US PAD districts. 5 tables.

9645 (DOE/EIA—0184/20) **Sensitivity analysis of world oil prices. Analysis report AR/IA/79-47.** Rodekohr, M.; Cato, D. (Department of Energy, Washington, DC (USA). Energy Information Administration). Sep 1979. 48p. Dep. NTIS, PC A03/MF A01.

An analysis of the impact of the political disruption in Iran on the world oil market is presented. During the first quarter of 1979, this disruption caused a loss of approximately 5 million barrels per day (MMBD) of oil production available for export from Iran to the rest of the world. This loss of production and the political climate in Iran have caused much speculation concerning future Iranian oil production and total Organization of Petroleum Exporting Countries (OPEC) oil production in the nearterm and midterm. The analysis describes these issues in terms of two critical factors: the world oil price and the level of OPEC oil production in the nearterm and midterm. A detailed comparison of the Central Intelligence Agency (CIA) and Energy Information Agency (EIA) forecasting models of world oil prices is presented. This comparison consists of examining reasons for differences in the price forecasts of the CIA model by using CIA assumptions within the EIA model. The CIA and EIA model structures and major parameters are also compared. It is important to note that this analysis is not all encompassing. In particular, the analysis does not provide data on crude oil prices in the spot market, but does provide information on the average crude oil price; and does not permit rationing of oil, since the market is forced to clear only through changes in oil prices. Throughout this paper, world oil prices are defined in terms of real 1978 dollars per barrel of crude oil delivered to the East Coast of the United States net of any import fees.

9646 (DOE/ERA/6379—2) **Analysis of the competitive viability of independent middle distillate marketers.** (Shriver (R.) Associates, Washington, DC (USA)). Nov 1979. Contract EB-78-C-01-6379. 288p. Dep. NTIS, PC A13/MF A01.

The viability of the home heating oil dealer is being threatened by changes in the basic conditions of the middle distillate industry. These changes, which were examined over the study period from 1972 through 1978, are summarized below. (1) The overall number of households using home heating oil for space conditioning has declined from 1970 to 1976. This pattern has occurred in an expanding market. The Northeast Census Region is the only area of the country in which the number of households using heating oil shows a net increase. (2) The quantity of home heating oil consumed by the residential sector has declined by 8.3 percent between 1972 and 1977. (3) The average level of consumption per household has declined 5.9 percent from 1970 to 1976. (4) Demand for distillate fuel oil as diesel fuel for on- and off-highway use; for industrial and oil company consumption; for vessels, railroads, and all other uses, has increased 14.5 percent. (5) Total refining capacity that is capable of producing middle distillates has increased 17 percent. (6) Total annual distillate output has increased 18 percent from 1974 through 1978. (7) Prices for home heating oil increased by more than 150 percent from 1972 to 1977, compared with 93 percent for the less expensive natural gas. Home heating oil dealers face a declining market, both in terms of number of households using the product and in terms of sales per household. Although total middle distillate supplies were adequate during the time period studied, the demand for distillate fuel oil for uses other than home heating oil may eventually put pressure on supplies. That is, downward pressure on prices, expected when supplies outstrip demand, may not occur because of the many alternative uses for home heating oil.

9647 (PB—292966) **Historic and projected demand for oil and gas in Alaska: 1972-1995.** O'Connor, K. (Alaska State Dept. of Natural Resources, Juneau (USA). Div. of Minerals and Energy Management). Apr 1977. 53p. NTIS PC A04/MF A01.

Included in this report are: (1) the historic oil and natural gas consumption from 1972 through 1975; (2) the projected demand for oil and natural gas to 1995; and (3) an addendum tabulating existing oil and gas fields and resources in Alaska.

9648 (USGS-OFR—79-1327) **Outer Continental Shelf Oil and Gas Information Program: Pacific index, January 1975-May 1979.** Benton, J.; McDowell, T.; Shearer, C. (Mitre Corp., McLean, VA (USA). METREK Div.). Jul 1979. 79p. Geological Survey, Box 25425, Denver, CO 80225.

A listing of all relevant, actual or proposed programs, plans, reports, environmental impact statements and other lease sale information are compiled for the Pacific region of Outer Continental Shelf (OCS) Oil and Gas Leasing Programs by the US Geological Survey. This volume contains a listing of documents used in the decision-making process. Bibliographic references are included.

9649 **State differences in the demand for gasoline: an econometric analysis.** Greene, D.L. (Oak Ridge National Lab., TN). *Energy Syst. Policy;* **3**: No. 2, 191-212(1979).

The development of policies for energy conservation in transportation should involve a consideration of how these policies will affect states and regions. This must be predicated on an understanding of the magnitude of state and regional differences in energy use and the factors responsible for those differences. This paper reports the results of an investigation into the determinants of household highway gasoline use at the state level. State highway gasoline sales per household in 1975 ranged from 864 gallons annually in New York to 2222 gallons in Wyoming. This study addresses the question of why these differences exist. A two-phase explanatory modeling approach was employed. A demand equation relating highway gasoline sales to socioeconomic variables is first estimated using data from the states and District of Columbia for 1966 to 1975. The demand equation also produces quantitative estimates of state-specific deviations from predicted consumption levels. In the second phase these state-specific effects are regressed against a set of cross-sectional variables describing such state characteristics as spatial structure, climate, and employment in agriculture. State highway gasoline sales per household were found to be negatively related to population density, urbanization, percentage of agricultural employment, severe winter weather, and small car share of the vehicle fleet. Positive relationships were found with the percentage of the population aged 18 to 44 and the level of tourist activity. 24 references.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 10525, 10563, 10602

9650 (AD-A—066302) **Determination of oil in water by organic carbon analysis. Final report, April 1972-September 1977.** Hearst, P.J. (Civil Engineering Lab. (Navy), Port Hueneme, CA (USA)). Jan 1979. 38p. NTIS, PC A03/MF A01.

A method was investigated for determination of oil in water by establishing the organic carbon content attributable to the oil and by converting this value to the oil content. Samples were homogenized with the aid of an emulsifier, and a correction was made for the carbon contributed by the emulsifier. Aliquots of 35 micros l or less were injected into the organic carbon analyzer because larger samples were incompletely combusted and gave reduced recoveries. With corrections for carbon content of the water or the seawater used to prepare the samples, samples containing 15 mg/l of white mineral oil or Navy distillate fuel gave recoveries of about 85% with standard deviations of about 10%. Samples of about 50 mg/l gave recoveries of about 65%. If the factor of 1.39, instead of the theoretical factor of 1.18, had been used to convert from carbon to oil content, the calculated recoveries would have been 100% for 15 mg/l oil samples and 76% for 50 mg/l oil samples. The method will give only an upper limit for the oil concentration unless a correction is made for dissolved organic materials.

9651 (AD-A—066572) **Development of a streaming-fiber oil spill control system. Stage II - modification to large-scale model. Final report, January 1977-August 1978.** Beach, R.L.; Durfee, D.W. (Seaward International, Inc., Falls Church, VA (USA)). Aug 1978. Contract DOT-CG-40217-A. 96p. NTIS, PC A05/MF A01.

The large-scale model of the Streaming-Fiber fast current oil skimmer was modified to improved performance in waves and viscous oils. Modification included a sorbent foam belt rotation beneath the fiber array to intercept and collect any oil escaping from the fibers, and separate flotation for the fiber array to improve wave conformance by decoupling the array motions from the skimmer vessel. Testing indicated benefits from both of these modifications. The program involved small-scale foam capacity tests and small-scale model tests, as well as testing of the large-scale model atOHMSETT. A preliminary prototype design, utilizing the most promising developments of date, is included in the report.

9652 (EPS—3-EC-77-23) **Selected bibliography on the fate and effects of oil pollution relevant to the Canadian marine environment.** (Environmental Protection Service, Ottawa (Canada)). Dec 1977. 174p. Environmental Protection Service, Ottawa, Ontario.

A selected and indexed bibliography is presented on the fate and effects of oil pollution in cold waters. References were selected from the primary and technical scientific literature, both Canadian and otherwise, on the basis of their relevance to the Canadian

environment. The bibliography consists of two sections: an alphabetic listing of all references listed, and a KWIC Index, allowing full and rapid access to the listed references by author, key words, and subject.

9653 (PB—292626) **The law of the sea conference--status of the issues, 1978.** (General Accounting Office, Washington, DC (USA). International Div.). 9 Mar 1979. 58p. NTIS PC A04/MF A01.

Since 1958 the United Nations has convened three Law of the Sea conferences in an attempt to codify state practices regarding the oceans and to create an international oceans regime compatible with a changing international order. Seven sessions of the third Law of the Sea conference have been held between 1973 and 1978. This report discusses the issues as they stood at the end of the 1978 New York conference session.

9654 (PB—293597) **Research summary--oil spills.** Schaefer, M. (Environmental Protection Agency, Washington, DC (USA). Office of Research and Development). Feb 1979. 19p. NTIS PC A02/MF A01.

This summary of EPA Office of Research and Development (ORD) research in the oil spills area discusses current and emerging spill control technologies, the ecological effects of petroleum, and ORD's approach to transferring information about its research program to the appropriate users.

9655 (PB—293803) **Summary fact sheet: the Argo Merchant oil spill - a preliminary scientific report.** Grose, P.L.; Mattson, J.S. (National Oceanic and Atmospheric Administration, Washington, DC (USA)). Mar 1977. 18p. NTIS PC A02/MF A01.

Project investigators believe that, while the full impact of the Argo Merchant spill cannot be fully assessed in the short time since the incident, any effects will mainly involve area fisheries. Maximum petroleum hydrocarbon levels observed were 250 parts per billion, and these comparatively low levels were probably soon reduced to background values in a few days by turbulent mixing of the water column. Thus no long-term hydrocarbon contamination of the water column occurred as a result of the spill. But the full impact on fisheries remains to be assessed in continuing studies by fisheries biologists.

9656 (PB—294741) **Emission factors and frequency of leak occurrence for fittings in refinery process units. Interim report, March 1976-March 1979.** Wetherold, R.; Provost, L. (Radian Corp., Austin, TX (USA)). Feb 1979. Contracts EPA-68-02-2147;EPA-68-02-2665. 78p. NTIS, PC A05/MF A01.

The report gives results of sampling fugitive emissions at nine integrated oil refineries throughout the U.S. The petroleum refining industry is a significant source of atmospheric hydrocarbon (HC) emissions in the U.S. Each refinery has a large number of potential emission sources, both controlled (e.g., stacks and vents) and uncontrolled (e.g., leaks). HC emission data were collected for valves, flanges, pump and compressor seals, pressure relief valves, and process drains. The sampling techniques are presented. Potential leaking components were initially screened using portable HC detectors; screened devices which indicate significant emissions were then subjected to fully qualitative and quantitative sampling and analysis. For the nine refineries, 5680 sources were screened, 1250 of which were sampled and analyzed. Data on non-methane HC emission rates are presented for each fugitive source, with statistics on data variability. Information on frequency of leaks is also provided. These data show that most HC emissions from fugitive sources occur due to a relatively few leaking components. Gas/vapor streams contribute a proportionately greater amount of emissions than the light and heavy liquid streams.

9657 (PB—294813) **Modeling of stationary air pollution sources in the central and western Kern County oil fields. Task report. Volume II. Appendices.** Simmon, P.B.; Ludwig, F.L.; Nitz, K.C. (SRI International, Menlo Park, CA (USA)). Jan 1979. Contract EPA-68-01-4137. 78p. NTIS, PC A05/MF A01.

Sulfur dioxide pollution from steam-injection oil recovery and from other sources in Kern County, California, was studied with a mathematical model. This volume consists of tables of data and of a list of modifications made to the CDM program.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 9640

TRANSPORT, PIPELINES, AND HANDLING

9658 (NTIS/PS—79/0849) **Supertankers and superports (citations from the NTIS data base). Report for 1964-July 1979.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 196p. NTIS PC N01/MF N01.

Construction and operation of supertankers and requirements for port facilities are reviewed in these Government-sponsored research reports. The environmental aspects are investigated. (This updated bibliography contains 187 abstracts, 38 of which are new entries to the previous edition.)

9659 (NTIS/PS—79/0850) **Supertankers and superports (citations from the Engineering Index data base). Report for 1970-July 1979.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 123p. NTIS PC N01/MF N01.

Construction and operation of supertankers and requirements for port facilities are reviewed in these reports gathered from worldwide literature surveys. Environmental aspects, offshore mooring sites, and harbor preparation are among the features investigated. (This updated bibliography contains 117 abstracts, 6 of which are new entries to the previous edition.)

PROPERTIES

9660 (AD-A—070271) **Effectiveness of standard test fluids in evaluating the fuel resistance of elastomers. Technical report, July 1973-September 1978.** Gatza, P.E.; Touchet, P.; Powell, F.P. (Army Mobility Equipment Research and Development Center, Fort Belvoir, VA (USA)). Apr 1979. 53p. NTIS PC A04/MF A01.

The fuel resistance of representative elastometric compounds exposed in commercial leaded, low-leaded, and unleaded gasolines is investigated and related to the aromatic content of these fuels. Similar data are obtained for exposure in standard ASTM and military test fuels. The efficacy of these test fuels is discussed and an alternative nonbenzene containing test fluid of 40% aromatic content is proposed for inclusion in ASTM and military standards.

STORAGE

9661 (AD-A—066605) **Final report on crude and product storage: state-of-the-art review and assessment. Report for June-November 1978.** Bowden, J.N.; Stavinoha, L.L. (Southwest Research Inst., San Antonio, TX (USA). Army Fuels and Lubricants Research Lab.). Nov 1978. Contract DAAK70-78-C-0001. 74p. NTIS, PC A04/MF A01.

National policy has dictated that large reserves of petroleum be stored in order to diminish U.S. vulnerability to the effects of a severe petroleum supply interruption. To ensure that products being considered for storage would be of a quality immediately usable and to identify likely quality assurance procedures, an investigation program was undertaken. The first task under this program was to review and assess the state-of-the-art in petroleum crude and product storage. Through literature review, questionnaires, and personal contacts, considerable information was identified for use in programs relating to the effect of storage on the quality of finished petroleum products. As a result of this task, it has been determined that underground storage of refined distillate products can be accomplished with proper selection of products to be stored, through specification requirements, quality control/surveillance, and judicious use of additives.

COMBUSTION

REFER ALSO TO CITATION(S) 9593, 9618, 9680

NATURAL GAS

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 9631, 9632

9662 (ORO—5524-T1) **Geologic remote sensing over the Cottageville, West Virginia gas field. Final report, August 15, 1977-February 15, 1979.** Jackson, P.L.; Wagner, H.L.; Shuchman, R.A. (Environmental Research Inst. of Michigan, Ann Arbor (USA). Applications Div.). Feb 1979. Contract EF-77-C-05-5524. 98p. Dep. NTIS, PC A05/MF A01.

Remote sensing of geologic features was investigated for the purpose of exploration for gas reserves in the eastern Mississipian-Devonian Shales. The Cottageville gas field in Jackson and Mason Counties, West Virginia, was used as a test site for this purpose. Available photographic and multispectral (MSS) images from Landsat were obtained; also 4-channel synthetic aperture radar and 12-channel MSS in the range between ultraviolet and far infrared were

gathered by the Environmental Research Institute of Michigan over the test site. The images were first interpreted visually for lineaments. Then the images were enhanced by many different digital computation techniques in addition to analysis and enhancement by optical techniques. Subtle, interpretative lineaments were found which could not be enhanced to an obvious level by the procedures used. Two new spatial enhancement procedures were developed.

9663 Ratio of produced gas to produced water from DOE's EDNA Delcambre No. 1 geopressured-geothermal aquifer gas well test. Rogers, L.A.; Randolph, P.L. Chicago, IL; Institute of Gas Technology, Chicago, IL (1979). 53p. (CONF-7910104—1).

From 4. United States gulf coast geopressured-geothermal energy conference; Austin, TX, USA (29 Oct 1979).

A paper presented by the Institute of Gas Technology (IGT) at the Third Geopressured-Geothermal Energy Conference hypothesized that the high ratio of produced gas to produced water from the No. 1 sand in the Edna Delcambre No. 1 well was due to free gas trapped in pores by imbibition over geological time. This hypothesis was examined in relation to preliminary test data which reported only average gas to water ratios over the roughly 2-day steps in flow rate. Subsequent public release of detailed test data revealed substantial departures from the previously reported computer simulation results. Also, data now in the public domain reveal the existence of a gas cap on the aquifier tested. This paper describes IGT's efforts to match the observed gas/water production with computer simulation. Two models for the occurrence and production of gas in excess of that dissolved in the brine have been used. One model considers the gas to be dispersed in pores by imbibition, and the other model considers the gas as a nearby free gas cap above the aquifier. The studies revealed that the dispersed gas model characteristically gave the wrong shape to plots of gas production on the gas/water ratio plots such that no reasonable match to the flow data could be achieved. The free gas cap model gave a characteristically better shape to the production plots and could provide an approximate fit to the data of the edge of the free gas cap is only about 400 feet from the well.Because the geological structure maps indicate the free gas cap to be several thousand feet away and the computer simulation results match the distance to the nearby Delcambre Nos. 4 and 4A wells, it appears that the source of the excess free gas in the test of the No. 1 sand may be from these nearby wells. The gas source is probably a separate gas zone and is brought into contact with the No. 1 sand via a conduit around the No. 4 well.

9664 Geopressured aquifer simulator. Byrnes, A.P.; Rockar, E.M.; Randolph, P.L.; Kelkar, S.M. Chicago, IL; Institute of Gas Technology, Chicago, IL (1979). 27p. (CONF-7910104—2).

From 4. United States gulf coast geopressured-geothermal energy conference; Austin, TX, USA (29 Oct 1979).

Ten natural gas companies have funded the Institute of Gas Technology (IGT) development of a laboratory facility for fluid and core analyses at temperatures and pressures characteristic of geopressured aquifers. The facility has been designed and constructed to measure the following parameters at pressures up to 20,000 psi and temperatures to 450°F: solubility of methane in brines from actual geopressured aquifers; dependence of compression and compaction reservoir drive upon pressure; dependence of permeability upon reservoir pressure and temperatures; dependence of relative permeabilities to gas and to water upon the water saturation of pores, pressure, and temperature. Brine pumped through the core can be either gas-free or from a reservoir of brine with gas in solution. The facility is modular in design with major components including the reservoir of gas-saturated brine, high-pressure positive displacement pumps, and the core holder housed in a large oven. All components contacted by high-pressure, high-temperature brine are fabricated from Hastelloy C-276, Elgaloy, or Inconel 625 to avoid corrosion. The temperatures, pressures, differential pressure, and flow rates are controlled and/or recorded by a digital microcomputer/microprocessor. Operation will be controlled from a separate room and programmed; hands-off operation will be the normal mode of operation. The facility has been constructed and is now being tested.Following performance testing with Berea sandstone, initial emphasis will be upon studies of brine and available core from DOE's Pleasant Bayou No. 1 and No. 2 wells.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 9612, 9667, 9668

9665 (DOE/EIA—0131(77)) **Natural gas production and consumption: 1977. Energy data reports.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Nov 1978. 10p. Dep. NTIS, PC A02/MF A01.

This annual statistical report presents data on US quantity and value of marketed production, storage withdrawals and injections, and imports of natural gas. Also covered are disposition (consumption, exports, quantity stored, extraction loss, and adjustments) of US supplies and average value of natural gas at the wellheads. Interstate shipments, total consumption of natural gas by use (consumer deliveries, lease and plant fuel, and pipeline fuel), the quantity and value of natural gas deliveries by consumer type (residential, commerical, industrial, electric utilities, and others) are each shown. The production of natural gas liquids, the quantity of natural gas processed and extraction loss; the input to and output from storage, the producing gas and gas condensate wells in 5 PAD Districts and the estimated total of proved reserves of natural gas in the US are tabulated. A narrative section highlights data. 10 tables.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 9647, 9648, 9665

9666 (DOE/EIA—0102/36) **Natural gas pricing analysis: senate proposal. Analysis memorandum.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 11 Apr 1978. 22p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

This publication compares the cost of the Senate Proposal of 7 March 1978, to the natural gas pricing provisions under H.R. 8444, the House of Representatives version of the National Energy Act. The analysis provides a range of estimates instead of providing a point estimate of the revenue effects of the Senate proposal. The incremental revenue effects on natural gas products for three major pricing provisions of the proposal are discussed. The provisions are: the new gas pricing provision, the special incentive pricing provision, and deregulation in 1985. Production projections were made by the Energy Information Administration (EIA) mid-term oil and gas supply model. Average prices for existing interstate contract gas were based on Federal Energy Regulatory Commission data. Intrastate data were estimated by the EIA. 2 figures, 16 tables.

9667 (DOE/EIA—0129(77)) **Main line natural gas sales to industrial users: 1977. Energy data report.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 18 Dec 1978. 64p. Dep. NTIS, PC A04/MF A01.

Main line natural gas sales by interstate natural gas companies to industrial users are itemized for each of the most recent five years. Information included is company name, customer name, customer's Standard Industrial Classification (SIC), the type of sale (where available), the delivery point, and the State involved in transactions. Summaries tabulating sales by SIC; by State and SIC; and by natural gas companies and SIC are calculated. Also summarized are sales by State and type (offpeak, interruptible, and not specified) for the most recent year. An accompanying narrative highlights recent trends and makes comparisons between the two most recent years. 5 tables.

9668 (DOE/EIA—0130/6-8(78)) **Marketed production, imports and exports of natural gas: June-August 1978.** (Department of Energy, Washington, DC (USA). Energy Information Administration). Jan 1979. 6p. Dep. NTIS, PC A02/MF A01.

This monthly document provides information on the marketed production of natural gas in each of 16 states, all other states, and all states combined. Synthetic natural gas production is shown. Also given are imports to and exports from the United States. Data cover each of two most recent months available, the corresponding month of the previous year, and the current and previous year-to-date. Volume is given in billion cubic feet and billion cubic feet per day. Marketed production of natural gas represents gross withdrawals less gas used for repressuring and quantities vented and flared. Data from the previous year are revised. Some of the most recent data are estimated. June, July, and August 1978 data are given.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 10563, 10602

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 9666

PROPERTIES

REFER ALSO TO CITATION(S) 10408

COMBUSTION

REFER ALSO TO CITATION(S) 9576

9669 Extension of natural gas supply to industry by supplementing with medium Btu gases from coal. Gray, R.W. (Memphis Light, Gas and Water Div., Memphis, TN). pp 15-32 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

The Memphis Light, Gas and Water Fuel Gas Demonstration Plant concept comprises an installation engineered to generate and distribute industrial fuel gas of approximately 300 Btu/SCF. From 2800 tons of coal per day, the plant will produce 175 million cubic feet of gas daily, the equivalent of 50 billion Btu's or equivalent of 50 million cubic feet per day of natural gas. The Institute of Gas Technology's U-GAS Process, which utilizes a fluidized bed gasifier, will be used to gasify the coal. The overall project is being conducted in three phases over a 6 1/2-year period. An initial 26-month phase includes process studies, development work, definitive design and project cost estimates. Final engineering design and construction will be accomplished in the second phase spanning 32 months. Finally, plant operations and testing will be conducted over a 20-month period. The plant will then be operated as a commercial unit for 20 years. The estimated cost of the project is $208 million which will be cost-shared. MLGW's share of the cost will be financed with revenue bonds.

9670 Prospective requirements for burner flexibility. Belles, F.E.; Griffiths, J.C. (American Gas Association Labs., Cleveland, OH). pp 531-542 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

This paper describes initial calculations which have been made towards establishing test gases for observing the flexibility of natural gas burners. To date these calculations have been limited basically to considerations of lifting flames and yellow tipping.

9671 International alternatives for interchangeability prediction. France, D.H. (Science Applications, Inc., Oak Ridge, TN). pp 543-564 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

Accurate prediction methods are required to assess the potential combustion interchangeability of proposed second-family gas supplies. Although numerous techniques have been developed, no existing method is reliable or universally acceptable. The present study reviews selected international alternatives and discusses their inherent advantages and deficiencies. Recent British studies based on methane/hydrogen/propane/carbon dioxide-nitrogen mixtures, to improve the precision of the graphic technique developed by Gilbert and Prigg, are also reported. Although the developed graphic procedure provides improved prediction of the interchangeability of second-family gases, the coordinates are unable to predict complete combustion performance. In the absence of composition-based methods, the graphic technique incorporating Wobbe number and burning velocity factor provides a convenient prediction procedure for rapid evaluation, based on flame stability and thermal input, of the combustion interchangeability of a proposed gas supply and permits an indication of required gas treatment operations.

9672 Experience with interchange of non-pipeline for pipeline gas. Powell, A.S. (Consolidated Natural Gas Service Co., Inc., Cleveland, OH). pp 577-578 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

The experiences in the Consolidated Natural Gas System with interchange of non-pipeline gas for natural gas supplied by interstate pipelines have been in three general areas. These three areas are software studies, laboratory-scale experimental work and actual operations. Studies and evaluations have been made to anticipate the magnitude of problems which might be expected from introduction of non-pipeline supplies in parts of the Consolidated System. Among these have been evaluations of use of medium Btu gas by industry, use of LNG for all classes of service in restricted areas and use of high Btu SNGs. Experimental studies of non-pipeline gas supplies alternated with pipeline natural gas have been made in appliances. The most extensive experience has been with local production gases. Because of our location in Appalachia about 20 percent of our gas comes from wells drilled in the local sandstone formations. While the bulk of this gas is processed to remove liquids at an extraction plant operated by our Supply Corporation, some, because of source and amount, is used with only minor wellhead liquid separation. Also on occasions when the extraction plant must go off-line for service the gas which normally passes through it reaches customers with minimal processing. Local production ranges from coal-mine methane with a Btu/SCF value in the low 900s to rich gases above 1200 Btu/SCF. In addition to varying hydrocarbon composition such gases also contain varying amounts and kinds of sulfur compounds and inerts.

STORAGE

REFER ALSO TO CITATION(S) 9665, 10508

OIL SHALES AND TAR SANDS

9673 (NTIS/PS—79/0512) **Oil shale mining, processing, uses, and environmental impacts. Volume 3. 1978-April 1979 (citations from the Engineering Index data base). Report for 1978-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 118p. NTIS PC N01/MF N01.

Worldwide research on exploration, mining, retorting, chemistry, thermal studies, environmental impacts, and policies relating to oil shale research is discussed. A few abstracts deal with the production of synthetic fuels from shale oil and the economics of oil shale operations. (This updated bibliography contains 113 abstracts, 74 of which are new entries to the previous edition.)

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

9674 (LBL—9857(Rev.), pp 7-9) **Partitioning of major, minor and trace elements during in situ oil shale retorting.** Fox, J.P.; Giauque, R.D.; Pacas, A.L.; Thomas, J.F. Aug 1979.

In Oil shale research: chapter from the Energy and Environment Division annual report 1978.

The partitioning of 51 elements during the raw and spent shale, shale oil, and retort water is being studied. Products from the LETC controlled-state retort and from the LLL retorts were analyzed. Results indicate that most elements in oil shale are not volatilized and therefore are present in the spent shale. 2 figures, 1 table. (DLC)

SURFACE METHODS

9675 (UCID—18503) **Oil shale project run summary: small retort run S-14.** Ackerman, F.J.; Sandholtz, W.A.; Raley, J.H.; Tripp, L.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 68p. Dep. NTIS, PC A04/MF A01.

Retort run S-14 was a combustion run in the small retort conducted on Nov. 15-16, 1977. The charge of Anvil Points shale operated under a 50% steam - 50% air mixture. Results indicate that the broad particle size range in the packed bed increases nonuniformities in gas flow and bed retorting characteristics. Oil yield was 87%, hydrogen production amounted to 0.25 wt % of the raw shale. (DLC)

9676 Recovery of oil from oil shale. Tsai, S.C. (to Gulf Research and Development Co.). US Patent 4,158,638. 19 Jun 1979. Filed date 27 Mar 1978. 6p.

A process for recovering oil from oil shale containing kerogen which comprises contacting said oil shale at a reaction temperature of at least about 300°C sith steam having a partial pressure of at least about 450 psia (3.1 MPa) and an organic solvent having a boiling point at ambient pressure, that is, about 15 psia (0.1 MPa), of at least about 80°C. 1 table.

PURIFICATION

9677 Denitrogenation of syncrude . Smith, R.H. (to Atlantic Richfield Co.). US Patent 4,159,940. 3 Jul 1979. Filed date 6 Mar 1978. 4p.

A method is described for removing nitrogen from an essentially liquid syncrude feed obtained from at least one of oil shale, tar sands, and coal. The feed is mixed with at least one acid selected from the group consisting of sulfuric, phosphoric, or hydrochloric acid, and a first phase composed of syncrude low in nitrogen and a second phase composed of acid and syncrude high in nitrogen formed by settling. The two phases are then separated and only the phase high in nitrogen is catalytically hydrotreated thereby minimizing hydrogen consumption. 5 claims.

PROPERTIES AND COMPOSITION

9678 (LBL—9857(Rev.), pp 25) **Advances in soft x-ray fluorescence spectrometry for oil shale analyses.** Flexser, S.; Bowman, H.R.; Neil, J.M. Aug 1979.

In Oil shale research: chapter from the Energy and Environment Division annual report 1978.

Low-energy x-ray fluorescence spectroscopy was applied to the analysis of oil shale, and particularly to the determination of P, S, and Cl. Problems such as sample crystallization on cooling, background, and loss of organics during fusion were resolved; boric acid was found to suppress crystallization during cooling of samples fused with a $LiBO_2$ matrix. (DLC)

9679 (LETC/RI—79/8) **Complete elastic constants and stiffness coefficients for oil shale.** Chong, K.P.; Uenishi, K.; Smith, J.W. (Wyoming Univ., Laramie (USA). Dept. of Civil Engineering; Department of Energy, Laramie, WY (USA). Laramie Energy Technology Center). Nov 1979. 36p. Dep. NTIS, PC A03/MF A01.

Equations estimating Young's Moduli and Poisson's ratios for oil shale loaded perpendicular (E/sub z/, ν/sub zx/) and parallel (E/sub x/, ν/sub xy/) to the rock's bedding planes are developed and presented. These prediction equations are linear functions of the volume of organic matter in the rock. This organic volume, computed from Fischer assay oil yield, is the primary variable affecting mechanical properties of Green River Formation oil shale. The elastic constants are also complex functions of stress level. The prediction equations were developed statistically from results of a comprehensive testing program conducted on Green River Formation oil shale from the Mahogany zone and adjacent stratigraphic sections in a core taken near the Anvil Points Demonstration Mine in Colorado. In addition it is mathematically demonstrated that the 12 nonzero coefficients in the stiffness matrix for oil shale can be calculated from the same elastic constants. To summarize the relationships presented, all of the elastic constants and stiffness coefficients are calculated for a range of organic volumes and stress levels and presented in tabular form, providing complete three-dimensional characterization of Green River Formation oil shale.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 9593

9680 **Comparison of shale oil and residual fuel combustion.** Ekmann, J.; McCann, C.R.; Mathur, M.P.; Bienstock, D. pp 153-166 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

The results of a series of tests on shale oil and two types of residual fuel - No. 6 oil and a coal-oil mixture - are compared. All tests were run in a 100 HP firetube boiler instrumented to permit detailed heat balances, emission measurements and flame characterization. Operating conditions for the residual fuel tests bracketed the shale oil tests and permitted comparisons in the areas of thermal efficiency, particulate emissions - as indicated by plume opacity, nitrogen oxides emissions and average flame optical properties. In general, the shale oil performed like a distillate fuel, with efficiencies comparable to No. 6 oil firing. Plume opacity showed a strong dependence on excess air for the shale oil compared to the other fuels. Nitrogen oxides readings increased with increased fuel nitrogen content. Emissivity measurements showed values higher than would be expected with No. 6 oil and similar to those found for the coal-oil mixture flames.

HEALTH AND SAFETY

9681 (LA—8023-PR, pp 21-27) **Oil shale toxicity.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

The respiratory tract and the skin represent the two major avenues of contact with oil shale-related materials in the industrial environment. Our toxicology program focuses primarily on the potential respiratory hazard of the particulates associated with shale oil extraction (i.e., raw shale and various spent shales) and also upon the effects of skin exposure to both particulates and crude oils. Inhalation studies, analysis of respirable shale dust, and epidermal carcinogenesis were discussed.

9682 (LA—8023-PR, pp 55-59) **Effects of oil shale production.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

An occupational health study of the Paraho oil shale workers was initiated in FY 1978. This study includes an industrial hygiene evaluation of potential worker exposure and a comprehensive medical evaluation of Development Engineering, Inc. (DEI) employees, including collection of personal information to aid future epidemiologic follow-up. Major components of the Paraho oil shale plant are shown. The operations include underground mining, shale crushing, surface retorting, and support functions. Industrial hygiene studies at Paraho were performed as part of 2 programs: (1) experimental oil shale toxicology, and (2) occupational health studies on oil shale workers.

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 9674, 9681, 10550, 10603, 10613, 10654

9683 (LBL—9857(Rev.)) **Oil shale research: chapter from the Energy and Environment Division annual report 1978.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 32p. Dep. NTIS, PC A02/MF A01.

Thirteen papers are included which report on various studies of the environmental aspects of oil shale production. Separate abstracts were prepared for two of these papers; the remaining papers were previously abstracted. (This document is an excerpt from LBL-8619). (DLC)

NUCLEAR FUELS

EXPLORATION

REFER ALSO TO CITATION(S) 10413, 10414, 10415, 10416

9684 (GJBX—2(80)) **National Uranium Resource Evaluation Program. Hydrogeochemical and stream sediment reconnaissance basic data for Beeville NTMS Quadrangle, Texas. Uranium resource evaluation project.** (Oak Ridge National Lab., TN (USA)). 31 Oct 1979. Contract EY-76-C-13-1664. 252p. (K/UR—130). PC E06/MF E06.

Results of a reconnaissance geochemical survey of the Beeville Quadrangle, Texas are reported. Field and laboratory data are presented for 373 groundwater and 364 stream sediment samples. Statistical and areal distributions of uranium and possible uranium-related variables are displayed. A generalized geologic map of the survey area is provided, and pertinent geologic factors which may be of significance in evaluating the potential for uranium mineralization are briefly discussed. The groundwater data indicate that the northwestern corner of the quadrangle is the most favorable for potential uranium mineralization. Favorability is indicated by high uranium concentrations; high arsenic, molybdenum, and vanadium concentrations; and proximity and similar geologic setting to the mines of the Karnes County mining district. Other areas that appear favorable are an area in Bee and Refugio Counties and the northeastern part of the quadrangle. Both areas have water chemistry similar to the Karnes County area, but the northeastern area does not have high concentrations of pathfinder elements. The stream sediment data indicate that the northeastern corner of the quadrangle is the most favorable for potential mineralization, but agricultural practices and mineralogy of the outcropping Beaumont Formation may indicate a false anomaly. The northwestern corner of the quadrangle is considered favorable because of its proximity to the known uranium deposits, but the data do not seem to support this.

MINING

REFER ALSO TO CITATION(S) 9732

FEED PROCESSING

REFER ALSO TO CITATION(S) 9687, 9730, 10551

9685 **Licensed fuel facilities.** *Nucl. Saf.;* **20**: No. 4, 491-492(Jul 1979).

Licensed fuel facilities (uranium mills, fuel fabrication plants, UF_6 conversion, and certain fuel research and development laboratories) are identified. The following information is tabulated: company; license number; type facility; location; plant capacity; and status.

ENRICHMENT

REFER ALSO TO CITATION(S) 9612

FUELS PRODUCTION AND PROPERTIES

REFER ALSO TO CITATION(S) 9685

9686 (ORNL/TM—6640) **Nuclear fuel fabrication and refabrication cost estimation methodology.** Judkins, R.R.; Olsen, A.R. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 70p. Dep. NTIS, PC A04/MF A01.

The costs for construction and operation of nuclear fuel fabrication facilities for several reactor types and fuels were estimated, and the unit costs (prices) of the fuels were determined from these estimates. The techniques used in estimating the costs of building and operating these nuclear fuel fabrication facilities are described in this report. Basically, the estimation techniques involve detailed comparisons of alternative and reference fuel fabrication plants. Increases or decreases in requirements for fabricating the alternative fuels are identified and assessed for their impact on the capital and operating costs. The impact on costs due to facility size or capacity was also assessed, and scaling factors for the various captial and operating cost categories are presented. The method and rationale by which these scaling factors were obtained are also discussed. By use of the techniques described herein, consistent cost information for a wide variety of fuel types can be obtained in a relatively short period of time. In this study, estimates for 52 fuel fabrication plants were obtained in approximately two months. These cost estimates were extensively reviewed by experts in the fabrication of the various fuels, and, in the opinion of the reviewers, the estimates were very consistent and sufficiently accurate for use in overall cycle assessments.

9687 (ORNL/TM—7143) **Development of nuclear fuel microsphere handling techniques and equipment.** Mack, J.E.; Suchomel, R.R.; Angelini, P. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 25p. Dep. NTIS, PC A02/MF A01.

Considerable progress has been made in the development of microsphere handling techniques and equipment for nuclear applications. Work at Oak Ridge National Laboratory with microspherical fuel forms dates back to the early sixties with the development of the sol-gel process. Since that time a number of equipment items and systems specifically related to microsphere handling and characterization have been identified and developed for eventual application in a remote recycle facility. These include positive and negative pressure transfer systems, samplers, weighers, a blender-dispenser, and automated devices for particle size distribution and crushing strength analysis. The current status of these and other components and systems is discussed.

9688 **Isotopically selective excitation from plural low levels to distinct excited levels.** Rostler, P.S. (to Jersey Nuclear-Avco Isotopes, Inc.). US Patent 4,158,139. 12 Jun 1979. Filed date 6 Oct 1976. 8p.

A system is described for producing isotopically selective excitation of particles of a predetermined isotope type in a mixture of isotopes from plural low-lying energy levels to respective, plural excited energy levels. Ionization and separate collection of particles of the predetermined isotope type are then achieved through further excitations through a single, further excited energy state. Decay losses from the second excited energy states are reduced due to distribution of the excited particles among several states and resulting lower cross-sections for self-lasing decay.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 9730, 9733, 9735, 9739, 10411

9689 **Coprocessing solvent extraction studies.** Okamoto, M.S.; Thompson, M.C. (E.I. du Pont de Nemours and Co., Aiken, SC). *Nucl. Technol.;* **43**: No. 2, 126-131(Apr 1979).

A coprocessing solvent extraction flowsheet for recovery and purification of light water reactor (LWR) fuels has been developed. This flowsheet never completely separates uranium from plutonium. The flowsheet has changed operation of the partitioning contactor to achieve partial partitioning of uranium and plutonium. Partial partitioning has been demonstrated with simulated feeds and irradiated LWR fuel solutions with hydroxylamine nitrate reductant to concentrate the plutonium by factors of 6 to 27.4. Nitrite was shown to interfere with the reduction of plutonium. Increased hydroxylamine concentrations gave normal reduction behavior. 7 figures, 5 tables.

9690 (DP—1500) **Processing of irradiated, enriched uranium fuels at the Savannah River Plant.** Hyder, M.L.; Perkins, W.C.; Thompson, M.C.; Burney, G.A.; Russell, E.R.; Holcomb, H.P.; Landon, L.F. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Apr 1979. Contract EY-76-C-09-0001. 237p. Dep. NTIS, PC A11/MF A01.

Uranium fuels containing ^{235}U at enrichments from 1.1% to 94% are processed and recovered, along with neptunium and plutonium byproducts. The fuels to be processed are dissolved in nitric acid. Aluminum-clad fuels are disssolved using a mercury catalyst to give a solution rich in aluminum. Fuels clad in more resistant materials are dissolved in an electrolytic dissolver. The resulting solutions are subjected to head-end treatment, including clarification and adjustment of acid and uranium concentration before being fed to solvent extraction. Uranium, neptunium, and plutonium are separated from fission products and from one another by multistage countercurrent solvent extraction with dilute tri-n-butyl phosphate in kerosene. Nitric acid is used as the salting agent in addition to aluminum or other metal nitrates present in the feed solution. Nuclear safety is maintained through conservative process design and the use of monitoring devices as secondary controls. The enriched uranium is recovered as a dilute solution and shipped off-site for further processing. Neptunium is concentrated and sent to HB-Line for recovery from solution. The relatively small quantities of plutonium present are normally discarded in aqueous waste, unless the content of ^{238}Pu is high enough to make its recovery desirable. Most of the ^{238}Pu can be recovered by batch extraction of the waste solution, purified by counter-current solvent extraction, and converted to oxide in HB-Line. By modifying the flowsheet, ^{239}Pu can be recovered from low-enriched uranium in the extraction cycle; neptunium is then not recovered. The solvent is subjected to an alkaline wash before reuse to remove degraded solvent and fission products. The aqueous waste is concentrated and partially deacidified by evaporation before being neutralized and sent to the waste tanks; nitric acid from the overheads is recovered for reuse.

9691 (ORNL—5572) **Project summary plan for HTGR recycle reference facility.** Baxter, B.J. (Science Applications, Inc., Oak Ridge, TN (USA); JBF Associates, Knoxville, TN (USA); Boeing Engineering and Construction Co., Seattle, WA (USA)). Nov 1979. Contract W-7405-ENG-26. 346p. Dep. NTIS, PC A15/MF A01.

A summary plan is introduced for completing conceptual definition of an HTGR Recycle Reference Facility (HRRF). The plan describes a generic project management concept, often referred to as the requirements approach to systems engineering. The plan begins with reference flow sheets and provides for the progressive evolution of HRRF requirements and definition through feasibility, preconceptual, and conceptual phases. The plan lays end-to-end all the important activities and elements to be treated during each phase of design. Identified activities and elements are further supported by technical guideline documents, which describe methodology, needed terminology, and where relevant a worked example.

9692 (RFP—3036) **Chemical research studies for the recovery of americium at Rocky Flats.** Hagan, P.G. (Atomics International Div., Golden, CO (USA). Rocky Flats Plant). 1980. Contract EY-76-C-04-3533. 16p. (CONF-800303—3). Dep. NTIS, PC A02/MF A01.

From 179. national meeting of the American Chemical Society; Houston, TX, USA (23 Mar 1980).

Americium is recovered from plutonium and pyrochemical waste salts at Rocky Flats by an aqueous chemical process. The process is a five-step operation: dissolution of the chloride salt, conversion from the chloride to the nitrate system by cation exchange, separation of plutonium by anion exchange, evaporation of the anion column effluent, and precipitation of americium as the oxalate. Recent research is discussed that shows the process can be improved through procedural modifications; for example: (1) by diluting the feed stream the selective sorption of the actinides by cation resin is increased, (2) by rinsing the cation resin with 1.5N nitric acid the carryover of impurities with the actinides is reduced, and (3) by lowering the molarity of the oxalate ion concentration and adding a small amount of chloride ion, during the oxalate precipitation step, the coprecipitation of lead impurity is reduced.

9693 **Photochemically produced U(IV) as a reductant for Pu(IV) and applications in nuclear fuel reprocessing.** DePoorter, G.L.; Rofer-DePoorter, C.K.; Hayter, S.W. (Los Alamos Scientific Lab., NM). *Nucl. Technol.;* **43**: No. 2, 132-135(Apr 1979).

U(IV) can be photochemically produced in tri-n-butyl phosphate solutions from uranyl nitrate and used to reduce Pu(IV). Nitrite production can be controlled by filtering out light having wavelengths of < 350 nm and by keeping the temperature of the reaction mixture below 10°C. Another product of the photolysis, di-n-butyl phosphate, can interfere with the reduction, but no effect was apparent in our experiments. Conventional solvent cleanup procedures should remove photolysis side products. The application of this process to the reprocessing of nuclear fuel would require commercially available light sources that can be located outside the

hot zone of the plant and a reactor vessel with windows within the hot zone. 1 figure, 1 table.

9694 Exxon nuclear fuel recovery and recycling center: process description. Ritter, G.L. (Exxon Nuclear Co., Inc., Richland, WA). *Nucl. Technol.;* **43**: No. 2, 194-202(Apr 1979).

The Purex solvent extraction process will be used in the nuclear fuel recovery and recycling center to reprocess up to 2100 MT/yr of spent light water reactor fuels. Modifications to the process will be made to improve fission product decontamination and to treat gaseous and liquid radioactive waste streams. These modifications will allow overall decontamination factors for most fission products from recovered uranium and plutonium of $> 10^{10}$. No liquid process wastes will be released, and releases of radioactive materials in gaseous effluents will be as low as reasonably achievable. 7 figures, 2 tables.

9695 Exxon nuclear fuel recovery and recycling center facility description. Birchler, J.E.; Caudill, H.L. (Exxon Nuclear Co., Inc., San Francisco, CA). *Nucl. Technol.;* **43**: No. 2, 203-212(Apr 1979).

Exxon Nuclear Company, Inc. has submitted an application to the US Nuclear Regulatory Commission for a construction permit to build a 1500 MT/yr (expandable to 2100 MT/yr) reprocessing plant on the Oak Ridge Reservation in Tennessee. The proposed plant utilizes the basic Purex solvent extraction process for recovering uranium and plutonium from spent nuclear fuel. A basic design objective of the nuclear fuel recovery and recycling center (NFRRC) is to ensure that the plant personnel and the general public are not exposed to excessive radiation. This is accomplished through the application of engineered confinement systems and the incorpation of confinement features in the various facilities and support systems. The design featues include those employed (a) to withstand environmental and accident forces and (b) to ensure radiological protection. The NFRRC is comprised of two interconnected principal facilities with their related support facilities. These are the fuel receiving and storage facility and the fuel reprocessing facility. 2 figures.

9696 Safety analysis for the nuclear fuel recovery and recycling center. Lakey, L.T. (Exxon Nuclear Co., Inc., Richland, WA). *Nucl. Technol.;* **43**: No. 2, 213-221(Apr 1979).

As part of the preliminary design for a proposed nuclear fuel reprocessing plant to be located near Oak Ridge, Tennessee, Exxon Nuclear Company, Inc. has made an extensive analysis of the environmental effects to the public from accidents occurring within the reprocessing complex. Each plant system was reviewed for its response to a spectrum of abnormal events, including natural phenomena, utility failures, equipment failures, operating errors, and process upsets. The analysis has shown that the plant is designed with sufficient confinement barriers and redundancy that in-plant accidents would not result in excessive radiation doses to the public. 2 figures, 1 table.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 9734, 10126

9697 (PNL-SA—6521) **Analysis of freight train accident statistics for 1972-1974.** Murphy, E.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 8p. (CONF-780506—42). Dep. NTIS, PC A02/MF A01.

From 5. symposium on packaging and transportation of radioactive materials; Las Vegas, NV, USA (7 May 1978).

Both train speed and dollar damage have been used in transportation studies as measures of accident severity. Analysis of freight train accident data for the three year period, 1972-74 showed that, in general, as speed increases dollar damage to railroad property also increases. A greater percentage of high speed than low speed accidents result in high dollar damage. Factors, in addition to speed, that can have an important effect on accident severity include the type of accident, the kinds of railcars and other equipment involved, and the geographical environmental of the accident. Threshold levels of accident stresses (e.g., impact and puncture forces and fire temperature and duration) are required to compromise the integrity of shipping containers used for the transport of radioactive materials. Analyses of accident severity using either speed or dollar damage as a basis can provide some insights into the possible risks involved in transport of radioactive materials. however, care must be taken in the strict use of results since there is no direct correlation between either speed or dollar damage and cask failure threshold levels.

9698 Design and operational characteristics of high-density fuel storage facilities. Grimm, E.A. (General Electric Co., San Jose, CA). *Nucl. Technol.;* **43**: No. 2, 146-154(Apr 1979).

General Electric (GE) experience in operation of the Morris spent fuel storage facility, which now contains over 300 Mg of both boiling water reactor (BWR) and pressurized water reactor spent fuel, confirms that receipt, handling, and storage of spent fuel can be accomplished safely with negligible impact on the environment or the operation itself. Basin water treatment is accomplished with disposable powdered resins applied to a precoated filter-demineralizer unit, and special applications of Zeolites aid in maintaining radiocobalt and radiocesium concentrations to $< 4 \times 10^{-4}$ μCi/ml in the basin water. No gaseous radioisotopes from damaged or leaking fuel have been observed, and no significant increases in radioactivity or loss of cladding integrity have been observed during fuel handling and storage. GE has utilized this experience to design an expansion of the Morris basin and to design Boral-poisoned, high-density, stainless-steel storage modules for BWR reactor pools. These free-standing modules store BWR fuel on 165.1-mm (6.5-in.) center spacing, and a sliding low-friction support system limits the seismic loads applied to the fuel. Application of this fuel storage experience has permitted expansion of storage capacity for spent fuel at Morris ad at BWR reactors, permitting continued operation until federal programs for long-term storage have been clarified and implemented. 8 figures.

9699 Subsurface storage of commercial spent nuclear fuel. Richards, L.M.; Szulinski, M.J. (ARCO-Polymers, Inc., Philadelphia). *Nucl. Technol.;* **43**: No. 2, 155-164(Apr 1979).

The Atlantic Richfield Company has developed the concept of storing spent fuel in dry caissons. Cooling is passive; safety and safeguard features appear promising. The capacity of a caisson to dissipate heat depends on site-specific soil characteristics and on the diameter of the caisson. It is estimated that ~ 2 kW can be dissipated in the length of one fuel element. Fuel elements can be stacked with little effect on temperature. A spacing of ~ 7.5 m (25 ft) between caissons appears rasonable. Business planning indicates a cost of ~ 0.2 mill/kWh for a 15-yr storage period. 12 figures, 4 tables.

9700 Spent fuel storage experience. Johnson, A.B. Jr. (Battelle-Pacific Northwest Labs., Richland, WA). *Nucl. Technol.;* **43**: No. 2, 165-173(Apr 1979).

Irradiated nuclear fuel has been stored in water pools at essentially all nuclear reactors, beginning with the earliest plants in 1943. Fuel from water-cooled power reactors is clad either with Zircaloy or with stainless steel. Zircaloy-clad fuel has been stored US pools since 1959. Some experimental stainless-steel-clad fuel was stored for 12 yr in the US before reprocessing. Canadian Zircaloy-clad fuel has been stored since 1962. There has been no evidence that the fuel has degraded during pool storage, based principally on visual observations and radiation monitoring of pool air and water. However, several fuel rods have been subjected to metallographic examination after pool exposures up to 11 yr, also with no evidence that the fuel cladding has degraded in the pool. Canadian fuel stored up to 10 yr was returned to a reactor and performed well. Favorable storage experience also has been indicated for other countries with fuel residence times of 5 to 10 yr. The pool storage environment is high-purity water at 5.3 to 7.5 pH, except for pools for pressurized water reactors, which utilize boric acid pool chemistry at 4.5 to 6.0 pH. Pool water temperatures generally range between 20 and 50°C. The favorable storage experience, demonstrated technology, successful handling of fuel with reactor-induced defects, benign storage environments, and corrosion-resistant materials offer sufficient bases to proceed with expanded storage capacities and extended fuel storage until questions regarding fuel reprocessing and final storage of nuclear wastes have been resolved. Some surveillance is justified to detect degradation if it becomes significat. Surveillance programs are already under way in several countries. 1 figure, 6 tables.

9701 Some aspects of the thermal analysis of metal-encapsulated spent fuel. Jardine, L.J.; Steindler, M.J. (Argonne National Lab., IL). *Nucl. Technol.;* **43**: No. 2, 273-284(Apr 1979).

A thermal analysis was made of a storage concept for a reference intact spent fuel assembly encapsulated in a metal matrix in a cylindrical canister. Maximum temperatures within the canister, as well as the canister surface temperatures, were estimated for interim storage of canisters in environments of a water basin, an air basin, and a vertical sealed storage cask. Comparisons of the thermal analyses of the metal-encapsulated concepts were made with a canister with an air filler (i.e., no metal encapsulation). A similar analysis was also made for a concept employing sheared spent fuel segments rather than an intact fuel assembly. 5 figures, 5 tables.

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 9686

WASTE MANAGEMENT

9702 (ANL/ES—80) **Engineering evaluation of a formerly utilized MED/AEC site. Site A and Plot M, Palos Forest Preserve,**

Palos Park, Illinois. (Argonne National Lab., IL (USA)). Sep 1979. Contract W-31-109-ENG-38. 76p. Dep. NTIS, PC A05/MF A01.

This engineering evaluation report (EER) addresses one of these MED/AEC sites known as Site A/Plot M, located in Palos Park, Illinois. The EER describes in technical detail a number of options for remedial action that could be taken with respect to the contamination at Site A/Plot M and presents estimates of the costs associated with these options. A companion document, Environmental Analysis Report on a Formerly Utilized MED/AEC Site, Site A and Plot M, Palos Forest Preserve, Palos Park, Illinois (ANL/ES-79), has also been prepared. It describes in detail the existing site environment and evaluates the environmental impacts of the various remedial options discussed in this report. This EER contributes to a better understanding of the mitigation or resolution of environmental problems posed by the subject MED/AEC site and serves as a basis for determining whether or not remedial actions are warranted. The knowledge derived from the evaluation of a number of remedial options should be helpful in the final disposition of other MED/AEC sites located elsewhere.

9703 (DP-MS—79-55) **Calculation of radionuclides in the defense waste processing facility.** Chandler, J.R.; Finch, D.R.; Becker, G.W. Jr. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 15p. (CONF-791103—51). Dep. NTIS, PC A02/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

SHIELD system calculations yield the isotopic inventory, activity, decay heat, and multigroup radiation source spectra for all of the DWPF process streams and for the solidified waste products. One application of these results is the analysis of the radiation emissions of the stored waste. Another application is the analysis of time dependent properties of the solidified waste. Initially, gamma radiation from /sup 137m/Ba decay contributes approximately one-third of the total energy. As the ^{137}Cs content decreases, the gamma contribution declines. The major producers of beta radiation are the ^{90}Sr, ^{137}Cs, and ^{144}Pr decay chains. As the glass age increases, however, the contribution from the actinides dominates increasingly. The inital activity level in the glass is 2000 curies per gallon. The activity and decay heat decrease by a factor of 2 in about fifteen years, and by a factor of 4 in fifty years. A similar analysis was made for the salt cake. Initially, the salt cake produces 0.01 watts per gallon from 2.4 curies per gallon of activity. In five years, the activity is reduced by a factor of 19, and the decay heat declines by a factor of 24. After ten years, both the activity and decay heat levels are less than 1% of their initial values. 7 figures, 4 tables.

9704 (KBS-TR—113, pp 1-19) **Chemical stability of ceramics.** Carlsson, R.; Hermansson, L. (Svenska Silikatforskningsinstitutet, Goeteborg (Sweden)). Sep 1978. (In Swedish).

In Studies of ceramic materials for encapsulation of high-active waste.

In this literature survey the chemical stability of ceramics in acid, neutral and basic hydrated environment has been studied. Furthermore different methods which are useful for the study of corrosion of ceramics are listed.

9705 (PNL-SA—7540) **Characterization of nuclear waste.** Platt, A.M. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 14 Feb 1979. Contract EY-76-C-06-1830. 6p. (CONF-790304—9). Dep. NTIS, PC A02/MF A01.

From 19. annual ASME symposium, geological disposal of nuclear waste; Albuquerque, NM, USA (15 Mar 1979).

Nuclear wastes which are logical candidates for deep geologic disposal include commercial (spent fuel, reprocessing) and defense wastes. It is expected that the 5250 metric tons of spent fuel discharged through the end of 1978 would increase to about 100,000 tons by the end of 2000. The individual characteristics of each waste type (spent fuel, solidified waste, defense wastes) are described in turn. (DLC)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 9725, 10411

9706 (DP—1545) **Preliminary evaluation of alternative forms for immobilization of Savannah River Plant high-level waste.** Stone, J.A.; Goforth, S.T. Jr.; Smith, P.K. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Dec 1979. Contract EY-76-C-09-0001. 98p. Dep. NTIS, PC A05/MF A01.

An evaluation of available information on eleven alternative solid forms for immobilization of SRP high-level waste has been completed. Based on the assessment of both product and process characteristics, four forms were selected for more detailed evaluation: (1) borosilicate glass made in the reference process, (2) a high-silica glass made from a porous glass matrix, (3) crystalline ceramics such as supercalcine or SYNROC, and (4) ceramics coated with an impervious barrier. The assessment includes a discussion of product and process characteristics for each of the eleven forms, a cross comparison of these characteristics for the forms, and the bases for selecting the most promising forms for further study.

9707 (K/ET—174) **Analysis of a non-isothermal gas stripper with volatile solvent.** Stephenson, M.J. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Aug 1979. Contract W-7405-ENG-26. 31p. (CONF-791108—13). Dep. NTIS, PC A03/MF A01.

From 72. AICHE meeting; San Francisco, CA, USA (25 Nov 1979).

The experimental and theoretical analysis of a non-isothermal packed column is given. A soluble gas concentration peak was found in all tests resulting from gross internal column condensation and reflux of the stripping vapor. A model is presented based on the conventional two-film mass and heat transfer theory. A combination absorber-stripper column is described that is based on the internal peaking phenomenon.

9708 (NUREG—0643) **Radioactive waste processing and disposal.** (Nuclear Regulatory Commission, Washington, DC (USA)). Jan 1980. 942p. (TID—3311-S8-P2). Dep. NTIS, PC A99/MF A01.

This compilation contains 4144 citations of foreign and domestic reports, journal articles, patents, conference proceedings, and books pertaining to radioactive waste processing and disposal. Five indexes are provided: Corporate Author, Personal Author, Subject, Contract Number, and Report Number.

9709 (PNL-SA—6768) **Full-scale in-can melter demonstration for vitrification of nuclear waste.** Blair, H.T. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 19p. (CONF-780622—82). Dep. NTIS, PC A02/MF A01.

From ANS annual meeting; San Diego, CA, USA (18 Jun 1978).

A full-scale, nonradioactive in-can melter was made operational in April of 1977 at Pacific Northwest Laboratory (PNL). The furnace's six independently controlled hot zones are capable of providing 30 kW each at 1200°C and are able to accommodate canisters up to 28 in. in dia and 7.5 ft tall. Several new system concepts were demonstrated with this equipment. These included supporting the canister from the bottom, placing the entire can within the furnace, and charging the melter through a water-cooled spout. These new concepts allowed one to eliminate accumulations both of batch over the top of the heat transfer plates and of unvitrified waste in the top of the can by using a test batch of simulated acid waste composition combined with borosilicate glass former; one was able to attain a melting rate of 117 kg/h in a 28-in.-dia canister. A 10-day continuous run was also made in conjunction with a heated wall spray calciner to demonstrate equipment reliability and operability. In addition, the operation of the in-can melting process was demonstrated using only remote monitoing equipment outside of the canister.

9710 **Removal of actinides from selected nuclear fuel reprocessing wastes.** Navratil, J.D.; Thompson, G.H. (Rockwell International, Golden, CO). *Nucl. Technol.;* **43**: No. 2, 136-145(Apr 1979).

The US Department of Energy awarded Oak Ridge National Laboratory a program to develop a cost-risk-benefit analysis of partitioning long-lived nuclides from waste and transmuting them to shorter lived or stable nuclides. Two subtasks of this program were investigated at Rocky Flats. In the first subtask, methods for solubilizing actinides in incinerator ash were tested. Two methods appear to be preferable: reaction with ceric ion in nitric acid or carbonate-nitrate fusion. The ceric-nitric acid system solubilizes 95% of the actinides in ash; this can be increased by 2 to 4% by pretreating ash with sodium hydroxide to solubilize silica. The carbonate-nitrate fusion method solubilizes ≧ 98% of the actinides, but requires sodium hydroxide pretreatment. Two additional disadvantages are that it is a high-temperature process, and that it generates a lot of salt waste. The second subtask comprises removing actinides from salt wastes likely to be produced during reactor fuel fabrication and reprocessing. A preliminary feasibility study of solvent extraction methods has been completed. The use of a two-step solvent extraction system - tributyl phosphate (TBP) followed by extraction with a bidentate organophosphorous extractant (DHDECMP) - appears to be the most efficient for removing actinides from salt waste. The TBP step would remove most of the plutonium and > 99.99% of the uranium. The second step using DHDECMP would remove > 99.91% of the americium and the remaining plutonium (> 99.98%) and other actinides from the acidified salt waste. 8 figures, 11 tables.

9711 **Liquid waste handling facilities for a conceptual light water reactor spent fuel reprocessing complex.** Witt, D.C.; Bradley, R.F. (E.I. duPont de Nemours and Co., Aiken, SC). *Nucl. Technol.;* **43**: No. 2, 244-258(Apr 1979).

One alternative for closing the nuclear fuel cycle is efficient, high decontamination separation of uranium and plutonium and fabrication of a Pu-U mixed-oxide fuel. Detailed flowsheets were prepared by Savannah River Laboratory for a conceptual 10 MT/day reprocessing facility. The generation of liquid waste and the

associated liquid waste handling facilities for the reprocessing plant were defined. Over 40 individual waste streams were identified. The reference facility generates 6.4 m^3 (1700 gal) of high-level liquid waste (HLLW) per day, which is converted to 0.5 m^3 (130 gal) of glass contained in three packages, each 0.3 m (12 in.) in diameter x 3 m (10 ft) high. Each operating day, the process converts 2.9 m^3 (775 gal) of concentrated intermediate-level liquid waste (ILLW) to 4 m^3 (1050 gal) of cemented solid in 21 carbon steel drums. Large-scale underground tank storage of liquid waste is eliminated by prompt solidification of the HLLW and ILLW. Each container of glass contains 30 kW nuclear decay heat and must be stored in water for an interim period prior to shipment to a federal repository. 10 figures, 1 table.

9712 Wiped-film evaporators for evaporating alkaline light water reactor radioactive wastes. Goodlett, C.B. (E.I. du Pont de Nemours and Co., Aiken, SC). *Nucl. Technol.;* **43**: No. 2, 259-267(Apr 1979).

Evaporation tests with synthetic alkaline wastes typical of intermediate-level waste streams from the processing of spent reactor fuel were made at the Savannah River Laboratory (SRL) with two small wiped-film evaporators [0.93 and 0.46 m^2 (10 and 5 ft^2) heat transfer area]. Each feed (six total) was processed separately within the operating range of each evaporator. Feed flows varied from 0.026 to 0.24 l/min (0.1 to 0.9 gal/min) in increments of 0.026 to 0.013 l/min (0.1 or 0.05 gal/min). Steam chest temperatures were maintained at 130, 150, 170, or 182°C. Rotor-tip speed was maintained at 10.7 m/s (35 ft/s). Concentrate and process condensate from the evaporator were sampled at each set of operating conditions. The concentrate sample was analyzed for density (at exit temperature), volume percent of solids at room temperature, weight percent of water, and sodium concentration. Each evaporator condensate sample was analyzed for sodium to calculate entrainment from the evaporator based on sodium carryover. All concentrates from waste feeds high in NaOH and $NaAlO_2$ flowed freely in liquid form out of the evaporator. Concentrates from waste feeds containing Na_2SO_4 and Na_2CO_3 included appreciable amounts of precipitated solids at high boildowns. The tests showed that all of the feeds could be converted in one pass to a free-flowing slurry that solidifies upon cooling to ambient temperature. 11 figures, 2 tables.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 9699, 9700, 9708, 9727, 9728, 9729, 9730, 9731, 10573, 10580, 10583, 10671, 10692, 10697

9713 (DP-MS—79-30) **Canister compatibility with Carlsbad salt.** Rankin, W.N. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 11p. (CONF-800305—1; CONF-791112—46). Dep. NTIS, PC A02/MF A01.

From Corrosion/80 NACE meeting; Chicago, IL, USA (6 Mar 1980).

No significant reaction was found when candidate canister alloys were heated with salt from Carlsbad, New Mexico, for up to 5000 hours in sealed capsules and for up to 10,000 hours in unsealed capsules at temperatures (80 to 225°C) that bracket the maximum temperature calculated for reference Savannah River Plant (SRP) waste containers at 20-foot spacings in salt. Additional tests were made at 600°C in sealed capsules to characterize reactions that may occur between candidate canister alloys and any component of the salt that is released when decrepitation occurs. Under these extreme conditions there was no significant attack of Type 304L stainless steel. But, there was up to 20-mils attack of the low-carbon steel.

9714 (KBS-TR—47, pp 78-96) **Three dimensional model of groundwater flow governed by topography.** Stokes, J.; Thunvik, R. (Tekniska Hoegskolan, Stockholm (Sweden)). May 1978.

In Investigations of groundwater flow in rock around repositories for nuclear waste.

As a complement to the two-dimensional computations for the Forsmark Area, a three-dimensional flow model was developed. In this model, which is a finite-element model, the conductivity is defined separately for each element. In this way fracture zones have been included as well as a conductivity varying in space. The results are presented as equipotentials, travel times and maps describing conditions of in- and out flow.

9715 (KBS-TR—47, pp 62-77) **Local groundwater depression around a repository.** Thunvik, R. (Tekniska Hoegskolan, Stockholm (Sweden)). May 1978.

In Investigations of groundwater flow in rock around repositories for nuclear waste.

A two-dimensional flow analysis was made to study the effect on the groundwater table due to drainage of the storage tunnels during the construction resp. operation period. The net accretion to the phreatic surface was assumed evenly distributed in space and time. Numerical examples with equipotentials and consecutive positions of the phreatic surface are presented.

9716 (KBS-TR—113, pp 1-48) **Report on stability of minerals at hydrothermal conditions.** Bergstroem, L. (Goeteborg Univ. (Sweden)). Sep 1978. (In Swedish).

In Studies of ceramic materials for incapsulation of high-active waste.

In the first part of this report summarizing discussions and recommendations are given while a literature survey together with references are presented in the second part.

9717 (KBS-TR—113, pp 1-7) **Proposal of materials for the storage of radioactive wastes.** Carlsson, R. (Svenska Silikatforskningsinstitutet, Goeteborg (Sweden)). Sep 1978. (In Swedish).

In Studies of ceramic materials for incapsulation of high-active waste.

On the basis of a literature study concerning the chemical stability of ceramics as well as of different experiencies of persons working with ceramics in Sweden a proposal of candidate materials for the storage of radioactive wastes is presented. Advantages and disadvantages in connection with the use of different ceramics have been tabulated.

9718 (KBS-TR—113, pp 1-16) **Al_2O_3 samples exposed to simulated underground water have been investigated by Electron Spectroscopy for Chemical Analysis (ESCA).** Olefjord, I.; Rilby, U. (Chalmers Tekniska Hoegskola, Goeteborg (Sweden)). Sep 1978. (In Swedish).

In Studies of ceramic materials for incapsulation of high-active waste.

Al_2O_3 samples, which have been exposed to simulated underground water during 30, 100 and 268 days at a temperature of 90 deg C and with pH=8.5, have been studied by ESCA (Electron Spectroscopy for Chemical Analysis). This technique was chosen due to its surface sensitivity and the possibilities to obtain information on the chemical condition of the surface layer and its thickness. Synthetic oxides and hydroxides as well as their correspondences normally formed on metals have also been studied.

9719 (LA—8152-PR) **Research and development related to the Nevada nuclear waste storage investigations. Progress report, July 1-September 30, 1979.** Crowe, B.M. (comp.). (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 14p. Dep. NTIS, PC A02/MF A01.

Sorption under anoxic conditions is reported for core samples of tuff from exploratory drill hole UE25a-1. Sorption for Sr, Cs, Ba, Ce, and Eu is somewhat lower in pure nitrogen than in ambient atmosphere, but generally by less than a factor of two. U and Tc sorb poorly in nitrogen; however, an increase over atmospheric conditions is noted for Tc. Final results for sorption of Pu and Am on core samples from drill hole J-13 are presented, and problems with Am are discussed. Ground water composition is found to be a major factor in sorption. Autoradiography indicates that Pu sorbs indiscriminately on rock thin sections and that Np deposits in aggregate form. Zeolite minerals are present within two distinct horizons of tuff in the stratigraphic section penetrated by exploratory drill hole UE25a-1. The horizons occur in low density tuff (partially to nonwelded and bedded tuff) within the lower part of and stratigraphically below Paintbrush Tuff. Zeolite minerals include clinoptilolite and minor amounts of low silica, high alkali mordenite. The zeolite is characteristic of low temperature (<100°C) ground water alteration of glass in an open hydrologic system. Prototype containment vessels for the hydrothermal soak tests have been assembled and tested. Regional studies of the occurrence and tectonic setting of Plio-Pleistocene age basaltic volcanic centers of the southern Great Basin are in progress. Revised volcanic disruption probability calculations for a 60-km radius circle around Yucca Mountain fall into the range of 10^{-9}/year. Petrographic and geochemical data for the basalts of Crater Flat show a strong control of basalt type with structural setting. Models of crystal-liquid fractionation of the basalts of Crater Flat using observed phenocryst phases cannot account for chemical variations of basalt types.

9720 (PB—292735) **Social decision-making for high consequence, low probability occurrences. Final report 1975-77.** (National Planning Association, Washington, DC (USA); Haldi Associates, Inc., New York (USA)). Oct 1978. Contract EPA-68-01-3228. 220p. NTIS PC A10/MF A01.

Part I reviews the two main classes of criteria proposed for social decisions: (1) market mechanisms and cost-benefit analysis and (2) the approaches of Rawls and Buchanan to arrive at a social consensus. The authors propose an eight element criteria for evaluating a social decision process capable of application in judicial, legislative, academic, and managerial situations. Parts II and III are case studies of different decision procedures. The former inspects the administrative law procedure using the U.S. EPA chlordane/heptachlor suspension hearings for example. The legal procedure is concluded to be a forward-looking decision process in an effort to

increase social acceptability of the outcome. The latter examines the disjointed decision procedure concerning the disposal of nuclear waste. In both cases the eight criteria proposed in Part I nevertheless provide a useful tool for evaluating the process.

9721 (PNL—3139) **Status of sorption information retrieval system.** Hostetler, D.D.; Serne, R.J.; Brandstetter, A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1979. Contract EY-76-C-06-1830. 64p. Dep. NTIS, PC A04/MF A01.

A Sorption Information Retrieval System (SIRS) is being designed to provide an efficient, computerized, data base for information on radionuclide sorption in geologic media. The data bank will include Kd values for a large number of radionuclides occurring in radioactive wastes originating from the commercial nuclear power industry. Kd values determined to date span several groundwater compositions and a wide variety of rock types and minerals. The data system will not only include Kd values, but also background information on the experiments themselves. This will allow the potential user to retrieve not only the Kd values of interest but also sufficient information to evaluate the accuracy and usefulness of the data. During FY-1979, the logic structure of the system was designed, the software programmed, the data categories selected, and the data format specified. About 40% of the approximately 5000 Kd experiments performed by the Waste Isolation Safety Assessment Program (WISAP) and its subcontractors during FY-1977 and FY-1978 have been evaluated, coded and keypunched. Additional software improvements and system testing are needed before the system will be fully operational. A workshop requested by the NEA was held to discuss potential international participation in the data system.

9722 (SAND—79-0344) **Small scale heater tests in argillite of the Eleana Formation at the Nevada Test Site.** McVey, D.F.; Thomas, R.K.; Lappin, A.R. (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 62p. Dep. NTIS, PC A04/MF A01.

Near-surface heater tests were run in the Eleana Formation at the Nevada Test Site, in an effort to evaluate argillaceous rock for nuclear waste storage. The main test, which employed a full-scale heater with a thermal output approximating commercial borosilicate waste, was designed to operate for several months. Two smaller, scaled tests were run prior to the full-scale test. This report develops the thermal scaling laws, describes the pretest thermal and thermomechanical analysis conducted for these two tests, and discusses the material properties data used in the analyses. In the first test, scaled to a large heater of 3.5 kW power, computed heater temperatures were within 7% of measured values for the entire 96-hour test run. The second test, scaled to a large heater having 5.0 kW power, experienced periodic water in-flow onto the heater, which tended to damp the temperature. For the second test, the computed temperatures were within 7% of measured for the first 20 hours. After this time, the water effect became significant and the measured temperatures were 15 to 20% below those predicted. On the second test, rock surface spallation was noted in the bore hole above the heater, as predicted. The scaled tests indicated that in-situ argillite would not undergo major thermostructural failure during the follow-on, 3.5 kW, full-scale test. 24 figures, 6 tables.

9723 (UCID—18502) **Climax granite test results.** Ramspott, L.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Jan 1980. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

The Lawrence Livermore Laboratory (LLL), as part of the Nevada Nuclear Waste Storage Investigations (NNWSI) program, is carrying out in situ rock mechanics testing in the Climax granitic stock at the Nevada Test Site (NTS). This summary addresses only those field data taken to date that address thermomechanical modeling for a hard-rock repository. The results to be discussed include thermal measurements in a heater test that was conducted from October 1977 through July 1978, and stress and displacement measurements made during and after excavation of the canister storage drift for the Spent Fuel Test (SFT) in the Climax granite. Associated laboratory and field measurements are summarized. The rock temperature for a given applied heat load at a point in time and space can be adequately modeled with simple analytic calculations involving superposition and integration of numerous point source solutions. The input, for locations beyond about a meter from the source, can be a constant thermal conductivity and diffusivity. The value of thermal conductivity required to match the field data is as much as 25% different from laboratory-measured values. Therefore, unless we come to understand the mechanisms for this difference, a simple in situ test will be required to obtain a value for final repository design. Some sensitivity calculations have shown that the temperature field is about ten times more sensitive to conductivity than to diffusivity under the test conditions.The orthogonal array was designed to detect anisotropy. After considering all error sources, anisotropic efforts in the thermal field were less than 5 to 10%.

9724 (Y/OWI/SUB—78/22340/4) **Executive-style briefings on selected repository design issues.** (Science Applications, Inc., Oak Ridge, TN (USA)). 2 Jun 1978. Contract W-7405-ENG-26. 45p. Dep. NTIS, PC A03/MF A01.

This document is a collection of executive-style briefings on selected repository design issues. Most of the briefings discuss differences between the US repository design bases presented in US Working Draft on Repository Physical Descriptions in a Salt Formation, prepared in support of INFCE discussions of May 1978 and the FRG-Netherlands design bases, presented in Design Study of a Radioactive Waste Repository to be Mined in a Medium-Size Salt Dome by Hamstra and Velzeboer, Netherlands Energy Research Foundation, January 1978. Advantages and disadvantages of the two sets of design bases are discussed, and the impacts of adopting either of these bases on the other's programs and positions are identified.

9725 **Radioactive waste management at the Hanford Reservation.** *Nucl. Saf.;* **20**: No. 4, 434-445(Jul 1979).

During some 30 years of plutonium production, the Hanford Reservation has accumulated large quantities of low- and high-level radioactive wastes. The high-level wastes have been stored in underground tanks, and the low-level wastes have been percolated into the soil. In recent years some programs for solidification and separation of the high-level wastes have been initiated. The Hanford waste-management system was studied by a panel of the Committee on Radioactive Waste Management of the National Academy of Sciences. The panel concluded that Hanford waste-management practices were adequate at present and for the immediate future but recommended increased research and development programs related to long-term isolation of the wastes. The panel also considered some alternatives for on-site disposal of the wastes. The Hanford Reservation was originally established for the production of plutonium for military purposes. During more than 30 years of operation, large volumes of high- and low-level radioactive wastes have been accumulated and contained at the site. The Management of these wastes has been the subject of controversy and criticism. To obtain a true technical evaluation of the Hanford waste situation, the Energy Research and Development Administration (now part of the Department of Energy) issued a contract to the National Academy of Sciences and the National Research Councilto conduct an independent review and evaluation of the Hanford waste-management practices and plans. A panel of the Committee on Radioactive Waste Management (CRWM) of the National Academy of Sciences conducted this study between the summer of 1976 and the summer of 1977. This article is a summary of the final report of that panel.

9726 **Leach rates of high activity waste from borosilicate glass.** Wiley, J.R. (E.I. du Pont de Nemours and Co., Aiken, SC). *Nucl. Technol.;* **43**: No. 2, 268-272(Apr 1979).

Borosilicate glasses containing actual high-level Savannah River Plant waste were leached in static, distilled water. Leach rates based on ^{90}Sr, ^{137}Cs, and plutonium analyses were similar: 10^{-5} to 10^{-6} g of glass/(cm^2.day) initially, 10^{-7} to 10^{-8} g/(cm^2.day) after two weeks, and 10^{-8} to 10^{-9} g/(cm^2.day) after 100 days. The leach rates were not directly correlated with waste composition, but were qualitatively related to the tendency of the glass to devitrify that could be caused by certain combinations of waste components. According to a proposed model, leach rates were diffusion-controlled during the entire 100-day test. 5 figures, 4 tables.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 9702, 9714, 9715, 9721, 10125, 10411, 10519, 10539, 10550, 10551, 10552, 10562, 10573, 10580, 10583, 10596, 10603, 10C54, 10670, 10697

9727 (L—7893-PR) **Laboratory studies of radionuclide distributions between selected groundwaters and geologic media. Progess report, April 1-June 30, 1979.** Erdal, B.R. (comp.). (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 56p. Dep. NTIS, PC A04/MF A01.

The Los Alamos Scientific Laboratory contribution to the Waste Isolation Safety Assessment Program, Task 4, for the third quarter of FY-79 involved plutonium, americium, and uranium(VI) batch sorption studies. The technetium sorption ratio on tuff was not found to be dependent on technetium concentration. Studies of the behavior of plutonium and americium in aqueous solutions at pH $\simeq$ 8 were continued. Studies of the sorption of strontium, cesium, barium, cerium, europium, uranium, and americium on salt dome materials were made under atmospheric and controlled atmosphere conditions. The first experiments to assess the dependence of sorption ratio on groundwater composition were started. Migration rate studies using crushed rock columns and fractured cores were continued. Additional chemical analyses were made, as were some studies of the sorption of plutonium and neptunium using a microautoradiographic technique.

9728 (ONWI—11(AECL-6325)) **Model for the transport of radionuclides and their decay products through geologic media.** Burk-

holder, H.C.; Rosinger, E.L.J. (Battelle Memorial Inst., Columbus, OH (USA); Atomic Energy of Canada Ltd., Ottawa, Ontario). Sep 1979. Contract EY-76-C-06-1830. 31p. Dep. NTIS, PC A03/MF A01.

The one-dimensional transport of radionuclides and their decay products from an underground nuclear waste isolation site through the surrounding geologic media to a surface environment is modeled. An ambiguity in the application of the previously reported mathematical solution for this problem has been clarified. The results of applying the solution described here compare favorably with the results of applying the former solution, but the present solution is computationally more efficient and less subject to numerical errors. Thus, this solution is presently being used by the authors and others to evaluate the sensitivity of potential radioactivity releases into the environment to the characteristics of various nuclear waste isolation systems. The model is expected to be used in the future as an analytical standard to which the accuracy of numerical codes can be compared.

9729 (PNL—2774) **Characterization of the Hanford 300 area burial grounds. Task IV. Biological transport.** Fitzner, R.E.; Gano, K.A.; Rickard, W.H.; Rogers, L.E. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 86p. Dep. NTIS, PC A05/MF A01.

The characteristics of radioactive waste burial sites at the 300 area burial grounds on the Department of Energy's Hanford Site, southeastern Washington were studied. The potential vectors of radionuclide transport studied were vegetation and animals. The overall results showed a low potential for uptake and transport of radionuclides from the 300 area sites. However, additional methods to control physical and biological mechanisms may contribute to the effectiveness of waste burial practices. From the results, the Biological Transport task recommended field studies which include reduction of soil erosion and addition of biobarriers to plants and animals. Vegetation plays a major role in reducing soil erosion, and thereby maintaining the backfill over the burial sites. Of the several species found on the 300 area sites, cheatgrass (Bromus tectorum) appears to be the most desirable as a cover. Besides retarding erosion, it has a shallow root system (does not easily penetrate buried material); it has a low affinity for radionuclide uptake; and its tissues are not easily blown away. Small mammals (specifically, mice) appear to have the most potential for radionuclide exposure and uptake. Small mammals were live-trapped within 10 x 10-meter trap grids. Each animal trapped was surgically implanted with a thermoluminescent dosimeter. When the animal was recaptured, the dosimeter was removed and read for exposure. Exposures were reported in milli-Roentgens. The most consistently trapped small mammals were the Great Basin pocket mouse (Perognathus parvus) and the deer mouse (Peromyscus maniculatus). Results from the dosimeter readings showed that some of those animals had higher than background exposures. Biobarriers to animals could be considered as a mechanism to reduce the potential for radionuclide transport.

9730 (PNL—3129) **Environmental control aspects for fabrication, reprocessing and waste disposal of alternative LWR and LMFBR fuels.** Nolan, A.M.; Lewallen, M.A.; McNair, G.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Nov 1979. Contract EY-76-C-06-1830. 94p. Dep. NTIS, PC A05/MF A01.

Environmental control aspects of alternative fuel cycles have been analyzed by evaluating fabrication, reprocessing, and waste disposal operations. Various indices have been used to assess potential environmental control requirements. For the fabrication and reprocessing operations, 50-year dose commitments were used. Waste disposal was evaluated by comparing projected nuclide concentrations in ground water at various time periods with maximum permissible concentrations (MPCs). Three different fabrication plants were analyzed: a fuel fabrication plant (FFP) to produce low-activity uranium and uranium-thorium fuel rods; a plutonium fuel refabrication plant (PFRFP) to produce plutonium-uranium and plutonium-thorium fuel rods; and a uranium fuel refabrication plant (UFRFP) to produce fuel rods containing the high-activity isotopes ^{233}U and ^{233}U. Each plant's dose commitments are discussed separately. Source terms for the analysis of effluents from the fuel reprocessing plant (FRP) were calculated using the fuel burnup codes LEOPARD, CINDER and ORIGEN. Effluent quantities are estimated for each fuel type. Bedded salt was chosen for the waste repository analysis. The repository site is modeled on the Waste Isolation Pilot Program site in New Mexico. Wastes assumed to be stored in the repository include high-level vitrified waste from the FRP, packaged fuel residue from the FRP, and transuranic (TRU) contaminated wastes from the FFP, PFRFP, and UFRFP. The potential environmental significance was determined by estimating the ground-water concentrations of the various nuclides over a time span of a million years. The MPC for each nuclide was used along with the estimated ground-water concentration to generate a biohazard index for the comparison among fuel compositions.

9731 (PNL-SA—7245) **Preliminary results on comparison of adsorption-desorption methods and statistical techniques to generate Kd predictor equations.** Serne, R.J.; Rai, D.; Relyea, J.F. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 12p. Dep. NTIS, PC A02/MF A01.

The radioactive waste isolation safety assessment program (WISAP) is being performed for the United States Department of Energy. A large bank of data have been collected under this program. A part of the program is devoted to the evaluation of radionuclide-geomedia interactions in order to determine the behavior of different elements in the environment. This paper introduces and briefly summarizes data collected thus far on methods of determining adsorption coefficients, thermodynamic predictions of stable solid and solution species, Kd data, and studies for determining adsorption mechanisms.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 10572, 10640, 10671, 10925

9732 (PB—292379) **Ambient airborne radioactivity measurements in the vicinity of the Jackpile open pit uranium mine New Mexico. Technical note (final).** Eadie, G.G.; Fort, C.W.; Beard, M.L. (Environmental Protection Agency, Las Vegas, NV (USA). Office of Radiation Programs; Indian Health Service, San Fidel, NM (USA)). Jan 1979. 91p. NTIS PC A05/MF A01.

This report discusses the results of several radiological surveys conducted in the vicinity of the Jackpile Open Pit Uranium Mine in New Mexico. During June 1976, ambient radon-222 concentrations were measured at eleven locations, seven of which appear to have been at representative background radon levels - averaging 0.50 + or - 0.033 pCi/l. The other four locations had average radon levels in excess of this typical background level; however, the highest measured radon concentration was 2.7 pCi/l. The arithmetic average ambient radon progeny working level obtained indoors at the Laguna Tribal Building appeared to be at a representative background level of 0.0049 + or - 0.00045 WL. The arithmetic average ambient working levels obtained at the Paguate Community Center and the Jackpile Housing were 0.035 + or - 0.0038 and 0.015 + or - 0.0025 WL, respectively. Ambient airborne particulate radioactivity concentrations measured outdoors at Old Laguna appear to be at typical background levels; however, other locations exhibited higher annual average concentrations for the naturally-occurring radionuclides.

9733 (PNL-SA—6523) **Considerations in the transportation of spent fuel and other radioactive materials by sea.** Rhoads, R.E.; Heaberlin, S.W.; Brobst, W.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 9p. (CONF-780506—43). Dep. NTIS, PC A02/MF A01.

From 5. symposium on packaging and transportation of radioactive materials; Las Vegas, NV, USA (7 May 1978).

A study was made of what would happen to casks and plutonium packages in the unlikely event of a serious sea accident involving shipments of spent fuel or plutonium, and what the radiological consequences might be to man through the marine food chain. Four postulated loss scenarios were considered: loss on the continental shelf and in the deep ocean of an undamaged package, and a package exposed to a severe fire. Conservative estimates of the maximum population doses are comparable to those expected from natural background sources. Areas where futher research is needed are identified. 3 tables. (DLC)

9734 (PNL-SA—6528) **Risks of shippng uranium hexafluoride by truck and train.** Johnson, J.F.; Andrews, W.B. (Battelle Pacific Northwest Labs., Richland, WA (USA)). May 1978. Contract EY-76-C-06-1830. 10p. (CONF-780506—45). Dep. NTIS, PC A02/MF A01.

From 5. symposium on packaging and transportation of radioactive materials; Las Vegas, NV, USA (7 May 1978).

Risk is defined as the product of the probability of a release of material to the environment and the consequences resulting from the release. Although a few accidents involving UF_6 containers have occurred during transportation, they are insufficient in number and consequences to provide data for a risk assessment of UF_6 transport. For this reason, this study used the predictive risk assessment methodology developed in the Transportation Safety Studies Project. The methodology is composed of four basic steps: detailed description of the transportation system, identification of possible material release sequences, evaluation of the probabilities and the consequences of the releases, and calculation and assessment of the risk. The system description includes projected industry characteristics, amounts to be shipped and the number of shipments required, material characteristics, transport mode and carrier., container types, routes (and any restrictions), and weather and population zones. Release sequences are identified using fault tree analyses. Releases are evaluated using container failure data and mathematical models for dispersion and health effects. The risk is then calculated and

compared to other known risks. Only releases resulting from transportation accidents or nonstandard container closures (or combinations of both) were considered. 5 figures, 2 tables.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

REFER ALSO TO CITATION(S) 10410, 10539

9735 (LA—8076-MS) **Nondestructive measurement of spent fuel assemblies at the Tokai Reprocessing and Storage Facility.** Phillips, J.R.; Bosler, G.E.; Halbig, J.K.; Lee, D.M. (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 36p. Dep. NTIS, PC A03/MF A01.

Nondestructive verification of irradiated fuel assemblies is an integral part of any safeguards system for a reprocessing facility. Available techniques are discussed with respect to the level of verification provided by each. A combination of high-resolution gamma spectrometry, neutron detectors, and gross gamma activity profile monitors provide a maximum amount of information in a minimum amount of time.

9736 (NUREG/CR—1214(Vol.1)) **Controllable unit approach to material control: application to a high through-put mixed oxide process.** Seabaugh, P.W.; Rogers, D.R.; Woltermann, H.A.; Fushimi, F.C.; Ciramella, A.F. (Mound Facility, Miamisburg, OH (USA)). 10 Jan 1980. Contract EY-76-C-04-0053. 217p. (MLM—2532(Vol.1)). Dep. NTIS, PC A10/MF A01.

CUA was applied to a 200-metric-ton mixed-oxide (4% PuO_2 in UO_2) process scheduled for completion in the 1980's. The performance criterion used was to detect a loss (single or cumulative) of 2 kg of PuO_2 from the mixed-oxide process over a two-month inventory period with a detection probability of 97.5%, and to detect the loss within one day of reaching the 2-kg magnitude. Since the mixed-oxide process does not yet exist, a detailed computer simulation program was developed based on a license application for a fuel fabrication plant proposed by the Westinghouse Corporation. In order to control the PuO_2, all process, quality, and material control measurements proposed by the licensee were taken into account through the formulation of closure equations. Although the CUA methodology suggested several specific refinements to the material control system, the results of this study show that the mixed-oxide process can meet the stated performance criterion without substantial modifications of the process or material control system.

9737 (PNL-SA—6650) **In situ quantitative determination of transuranic elements in areas of high-level gamma radiation.** Brodzinski, R.L.; Wogman, N.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 8p. Dep. NTIS, PC A02/MF A01.

A technique is described for passive neutron monitoring of transuranic elements. The method provides quantitative determinations of transuranic element concentrations in a variety of field situations where no other measurement method is possible. The technique can measure concentrations of transuranic oxides as low as 8 nCi/cm^3 and is capable of operating in gamma radiation fields up to megarads per hour. Information on chemical and isotopic composition can also be obtained from the data. Several successful applications of the technique are discussed.

9738 (SAND—79-1046C) **Active neutron technique for detecting attempted special nuclear material diversion.** Smith, G.W.; Rice, L.G. III. (Sandia Labs., Albuquerque, NM (USA)). 1979. Contract EY-76-C-04-0789. 18p. (CONF-791117—19). Dep. NTIS, PC A02/MF A01.

From ANS topical conference; Kiawah Island, SC, USA (26 Nov 1979).

The identification of special nuclear material (SNM) diversion is necessary if SNM inventory control is to be maintained at nuclear facilities. (Special nuclear materials are defined for this purpose as either ^{235}U of ^{239}Pu.) Direct SNM identification by the detection of natural decay or fission radiation is inadequate if the SNM is concealed by appropriate shielding. The active neutron interrogation technique described combines direct SNM identification by delayed fission neutron (DFN) detection with implied SNM detection by the identification of materials capable of shielding SNM from direct detection. This technique is being developed for application in an unattended material/equipment portal through which items such as electronic instruments, packages, tool boxes, etc., will pass. The volume of this portal will be 41-cm wide, 53-cm high and 76-cm deep. The objective of this technique is to identify an attempted diversion of at least 20 grams of SNM with a measurement time of 30 seconds.

9739 **Dynamic materials accounting in the back end of the light water reactor fuel cycle.** Dayem, H.A.; Cobb, D.D.; Dietz, R.J.; Hakkila, E.A.; Shipley, J.P.; Smith, D.B. (Los Alamos Scientific lab., NM). *Nucl. Technol.;* **43**: No. 2, 222-243(Apr 1979).

The US Department of Energy Office of Safeguards and Security is sponsoring the development of advanced safeguards systems for future industrial-scale nuclear fuel cycle plants. As part of this program, the Los Alamos Scientific Laboratory is engaged in conceptual design studies of integrated safeguards systems incorporating near-real-time (dynamic) materials accounting. Preliminary designs of advanced accounting systems have been completed for chemical separations, nitrate-to-oxide conversion, and mixed-oxide fuel refabrication processes. The proposed accounting systems combine current materials balance accounting methods with modern on-line measurement, data base management, and data analysis technologies. The results of these studies indicate that special nuclear materials can be safeguarded effectively in large-scale fuel cycle facilities. The design methodology and the insights gained from these studies are essential for the design of specific fuel cycle facilities and provide general design criteria to those planning such facilities. 10 figures, 10 tables.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

RADIATION SOURCES

9740 (SAND—79-1727) **Beneficial uses program. Progress report, period ending June 30, 1979.** (Sandia Labs., Albuquerque, NM (USA)). Oct 1979. Contract EY-76-C-04-0789. 49p. Dep. NTIS, PC A03/MF A01.

Progress in research on the irradiation of sewage sludge, the potential use of dried sewage sludge as animal feed or soil conditioners, the inactivation of rotavirus in sewage sludge, fruit fly control by the irradiation of citrus fruits, and the production of ^{137}Cs source pellets is reported. (LCL)

USE IN FOOD PROCESSING

REFER ALSO TO CITATION(S) 10659

HYDROGEN

PRODUCTION

9741 (NTIS/PS—79/0540) **Hydrogen production. Volume 1. 1964-1977 (a bibliography with abstracts). Report for 1964-1977.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 233p. NTIS PC N01/MF N01.

This bibliography contains citations on the manufacturing of hydrogen by electrolysis, coal gasification, and other techniques. They cover both experimental research and production on the industrial scale. Although most of the citations are on production methods, economic studies are also included. (This updated bibliography contains 227 abstracts, none of which are new entries to the previous edition.)

9742 (NTIS/PS—79/0541) **Hydrogen production. Volume 2. 1978-May 1979 (a bibliography with abstracts). Report for 1978-May 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 150p. NTIS PC N01/MF N01.

The cited reports include studies on the manufacturing of hydrogen by electrolysis, coal gasification, and other techniques. They cover both experimental research and production on the industrial scale. Although most of the reports are on production methods, economic studies are also included. (This updated bibliography contains 144 abstracts, 49 of which are new entries to the previous edition.)

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 9860

BIOSYNTHESIS AND PHOTOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 9850

9743 (PB—293051) **Biological and synthetic systems for production of hydrogen from water. Semi-annual progress report 1 mar 78-31 aug 78.** Krasna, A.I. (Columbia Univ., New York (USA). Dept. of Biochemistry). Aug 1978. 8p. NTIS PC A02/MF A01.

The production of hydrogen gas through photolysis of water catalyzed by intact cells, enzymes, or synthetic catalysts is investigated. Many functional systems of each type were discovered. The importance of removing oxygen, which is an inhibitory by-product, is shown. This must be done with an oxygen adsorbent in situ rather than in a separate compartment. Using mixed systems, many possible different electron donors, electron transport carriers, and different sources of hydrogenase are shown to .vork. The hydrogenase could be replaced by platinum or palladium asbestos. A very important finding is that deazaflavins catalyze the photoreduction of methyl viologen by amino acids. This leaves open the possibility that protein waste products from garbage or from some industries could be used to produce hydrogen from water as an important auxiliary energy source.

9744 (SERI/TP—33-409) **Improved hydrogen photoproduction from photosynthetic bacteria and green algae.** Weaver, P.F.; Lien, S.; Seibert, M. (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EG-77-C-01-4042. 21p. Dep. NTIS, PC A02/MF A01.

Photosynthetic bacteria evolve hydrogen at much higher rates than do other classes of photosynthetic microorganisms. In addition, they tolerate harsh environments, grow rapidly, and utilize both visible and near infrared light in photosynthesis. They do not split water, but this does not necessarily eliminate their potential use in future applied systems. They are easily manipulated genetically, and thus might be modified to metabolize common biomass waste materials in place of expensive defined organic substrates. Furthermore, the potential for increasing hydrogen photoproduction via genetic techniques is promising. Strains that partially degrade cellulose, have high photoproduction rates, or contain very large amounts of the enzymes associated with hydrogen metabolism have been isolated. Green algae also produce hydrogen but are capable of using water as a substrate. For example, C. reinhardi can evolve hydrogen and oxygen at a molar ratio approaching 2:1. Based upon effect of dichlorophenyl dimethylurea (a specific inhibitor of photosystem II, PSII) on hydrogen photoproduction in the wild type strain and upon results obtained with PSII mutants, one can demonstrate that water is the major source of electrons for hydrogen production. The potential efficiency of in vivo coupling between hydrogenase and the photosynthetic electron transport system is high. Up to 76% of the reductants generated by the electron transport system can be channeled directly to the enzyme for in vivo hydrogen production. Rates exceeding 170 μmoles of H_2 mg Chl^{-1} hr^{-1} have been observed.

9745 (SERI/TP—33-410) **Photobiological hydrogen production.** Seibert, M.; Lien, S.; Weaver, P.F. (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EG-77-C-01-4042. 19p. Dep. NTIS, PC A02/MF A01.

Hydrogen production by phototrophic organisms, which has been known since the 1930's, occurs at the expense of light energy and electron-donating substrates. Three classes of organisms, namely, photosynthetic bacteria, cyanobacteria, and algae carry out this function. The primary hydrogen-producing enzyme systems, hydrogenase and nitrogenase, will be discussed along with the manner in which they couple to light-driven electron transport. In addition, the feasibility of using in vivo and in vitro photobiological hydrogen producing systems in future solar energy conversion applications will be examined.

STORAGE

CHEMISORPTION

9746 (BNL—27093) **Bulk hydrogen storage using metal hydrides.** Strickland, G.; Rosso, M.J. Jr. (Brookhaven National Lab., Upton, NY (USA)). Dec 1979. Contract EY-76-C-02-0016. 10p. (CONF-791204—14). Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

The considerations involved in design and use of a process unit, or reservoir, for storing bulk quantities of hydrogen via solid particles of titanium-iron-manganese ($TiFe_{0.9}Mn_{0.1}H$/sub x/) are described along with several applications. Also included are one style of reservoir having improved design features, and the service system in which it was installed for testing. The reservoir has a nominal storage capacity of 50 lb (23 kg) of hydrogen and is rated for hydrogen charging and discharging times in the 5 to 10-hour range. Results of a limited test program will be provided in a summary report.

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 9576

9747 (CONF-7910105—2) **Methane recovery from urban refuse.** Wilkey, M.L.; Zimmerman, R.E. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 2. world energy engineering conference; Atlanta, GA, USA (28 Oct 1979).

The Methane Recovery from Sanitary Landfills Program is part of the DOE Urban Waste Technology (UWT) Program at Argonne National Lab. The overall goals and objectives of the UWT program at ANL are energy savings and recovery from urban waste streams. The goals of the Methane Recovery Program are to encourage participation in the development, evaluation, and implementation of the technologies necessary for recovery, processing, and utilization of combustible gases generated in landfills. To achieve these goals, a research program that examines the feasibility of landfill gas recovery and use, as well as future optimization techniques and methods, has been undertaken.

PROPERTIES

REFER ALSO TO CITATION(S) 9671, 9672, 10443

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 9570, 9571, 9572, 9573

9748 **Production of purified and humidifed fuel gas.** McGann, R. (to Texaco Inc.). US Patent 4,158,680. 19 Jun 1979. Filed date 22 Jul 1977. 10p.

This is a continuous process for producing a stream of purified and humidified fuel gas which may be burned in a gas turbine to produce mechanical work and electrical energy without contaminating the environment. In the process, a feed stream of raw fuel gas is preferably produced by the partial oxidation of a hydrocarbonaceous fuel with a free-oxygen containing gas, optionally in the presence of a temperature moderator. The raw fuel gas stream is then preferably saturated with water during cooling and cleaning operations. it is then passed in indirect countercurrent heat exchange with a stream of purified fuel gas containing substantially no water. The latter stream was produced by cooling and purifying said raw fuel gas stream. At least a portion of the water which is condensed out of the raw fuel gas during said cooling operation is separated and revaporized into said purified fuel gas stream. The resulting stream of purified and humidified fuel gas may be used as fuel in a gas turbine. Maximum low level heat recovery is achieved in the process along with providing the purified fuel gas stream with additinal mass for expansion in the turbine.

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 9777, 9839, 9840, 9843, 9845, 9846, 9849, 9850, 9854, 9857, 10600, 10601

9749 (CONF-791006—2) **Refuse conversion to methane (RefCOM): a proof-of-concept anaerobic digestion facility.** Walter, D.K.; Brooks, C. (Argonne National Lab., IL (USA); Department of Energy, Washington, DC (USA). Office of Building and Community Systems; Mittelhauser Corp., Downers Grove, IL (USA)). 1979. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From Joint power generation conference; Charlotte, NC, USA (7 Oct 1979).

The US Department of Energy (DOE) is developing a process for the anaerobic digestion of solid waste and sewage sludge into methane. Known as RefCOM - Refuse Conversion to Methane - the DOE experimental facility in Florida can process 100 tons of raw refuse per day with an output as high as 700,000 cubic feet of gas (CH_4 and CO_2) per day. Based on an average home gas consumption of one million cubic feet per year, a 1,000 tons-per-day plant has the potential to meet the gas needs of over 7,000 homes. The objectives of the RefCOM experiment are to: establish information on the quality and quantity of gas produced; ascertain optimum operating

parameters for both mesophilic and thermophilic modes; and evaluate the reliability of the techniques.

9750 (LBL—10199) **Synthesis gas utilization and production in a biomass liquefaction facility.** Figueroa, C.; Ergun, S. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract EY-76-C-06-1830;W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

A novel approach toward a combination biomass liquefaction and gasification process scheme is examined. The reactor arrangement is basically a liquefaction tubular coil reactor internally installed into a pressurized oxygen-blown Lurgi type gasifier. The potential for a dual purpose reactor is excellent due to lower capital costs. Advantages include: high radiant heat transfer, small reactor size, smaller compressor size, and a self-contained heating system for liquefaction. Disadvantages include: added capital costs for carbon dioxide removal and gas scrubbing. Without any energy recovery or mass recycle (CO_2) the thermal efficiency would be poor, perhaps as low as 51%.

9751 (NTIS/PS—79/0545) **Synthetic fuels from municipal, industrial, and agricultural wastes (citations from the NTIS data base). Report for 1964-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 172p. NTIS PC N01/MF N01.

Research efforts directed toward production of gaseous and liquid synthetic fuels from solid wastes are discussed. Waste products used in the syntheses include manure, sewage, paper, and wood. In most citations, methane is the primary fuel produced; however, the production of oils, methanol, and ethanol is also discussed. (This updated bibliography contains 164 abstracts, 50 of which are new entries to the previous edition.)

9752 (SERI/TP—33-285, pp 105-110) **Operations of the biomass liquefaction facility: Albany, Oregon, Wheelabrator Cleanfuel Corporation.** Berry, W.L. Jr. (Rust Engineering Co., Birmingham, AL). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of this contract is to obtain definitive process information sufficient for commercial design and economic evaluation purposes for the conversion of biomass to syncrude. This objective is to be accomplished through the execution of experimental and development programs in the Government-owned process development unit (PDU) located adjacent to the Bureau of Mines Metallurgical Research Center at Albany, Oregon. Operation of the plant is as directed by the Government and consists of the following phases of work: Phase I - preparatory work, including an environmental, health and safety assessment; Phase II - operating adjustment period; Phase III - continuation of process investigation; Phase IV - modification of plant configuration and/or process flowsheets; Phase V - process development operations; and Phase VI - shutdown and phaseout. Phases I and II have been completed. Phase III is underway. Test runs utilizing anthracene as the carrier vehicle have been underway since October with product oil concentrations of 38% produced. Testing continues to improve equipment reliability and to separate product oil from carrier vehicle. Additional equipment is being added to the system to improve performance. The first test run incorporating pretreatment of the wood with acid and alkaline hydrolysis, utilizing water as the carrier vehicle has been successfully completed. Additional quantative test runs are planned for this concept. Phases IV, V, and VI will be accomplished when sufficient data has been accumulated.

9753 (SERI/TP—33-285, pp 291-295) **Experimental anaerobic fermentation facility.** Lizdas, D.J.; Coe, W.B. (Hamilton Standard, Windsor Locks, CT). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The US Department of Energy awarded Hamilton Standard a contract (EG-77-C-01-4015) on September 30, 1977, for the design, construction, and experimental operation of an anaerobic fermentation facility to evaluate the technical and economic feasibility of producing a fuel gas from the residue of an environmental cattle feedlot. Design began in October 1977. Construction was initiated in Bartow, Florida at the Kaplan Industies feedlot in February 1978 and was completed in December 1978. Hamilton Standard will conduct an experimental evaluation through February 1980 to determine the commercial feasibility of the process.

9754 (SERI/TP—33-285, pp 309-316) **Biomass Energy Systems Program: an overview of thermochemical conversion activities.** Schiefelbein, G.F.; Sealock, L.J. Jr. (Pacific Northwest Labs., Richland, WA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of this program is to develop the capability for converting renewable biomass resources such as wood, agricultural residues, animal manure, and energy crops into clean fuels, substitute petrochemical feedstocks and other energy intensive products that can displace fossil fuels. Pacific Northwest Laboratory (PNL) has recently been selected to provide program management services to DOE's Biomass Energy Systems Program. PNL is responsible for the technical management of 14 biomass conversion projects funded by DOE's Division of Distributed Solar Technology. These projects are located throughout the United States and have an annual funding level of about 8 million dollars. This presentation will provide an overview of the Biomass Energy Systems Program with particular emphasis on the thermochemical conversion of biomass to fuels and feedstocks via direct combustion, direct and catalytic gasification, and indirect liquefaction. It will include a delineation of the Biomass Energy Systems Program's objectives and goals, organizational structure, implementation plan and program budget.

9755 (SERI/TP—33-285, pp 333-338) **Synthetic fuels from a large gasifier.** Flanigan, V.J. (Univ. of Missouri, Rolla); Omurtag, Y.; Halligan, J.E.; Welch, N.E. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The University of Missouri-Rolla's Large Gasifier project is a development program supported by the Department of Energy's Biomass Energy Systems Program. The UMR program is just beginning and at the present time is in the construction phase. Its purpose is to determine scale-up factors for low, medium, and high Btu gasification processes for transition from medium sized to commercial operations. The resource recovery system donated to the University of Missouri-Rolla by the Adolph Coors company will be modified and used to obtain the necessary development data. The program will include the operation of a fluidized bed reactor designed to handle mass flow rates of 200 to 2000 lbs/hr with and without a catalyst to determine optimum design and operating parameters for wood residue gasification. The modification and development will include the design and use of an inserted sleeve, which will provide an unusual two-reactors-in-one vessel arrangement. This sleeve will also make possible a wide range of operating conditions. Previous data collected by Coors and others are presented to support the system's design and configuration.

9756 (SERI/TP—33-285, pp 339-347) **Application of SGFM technology to other feedstocks.** Beck, S.R. (Texas Tech. Univ., Lubbock). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

In 1977 a contract was awarded to Texas Tech to evaluate non-manure biomass feedstocks in the Synthesis Gas From Manure (SGFM) pilot plant. These feedstocks were to include wood as the major emphasis, along with various agricultural residues which might be available. The agricultural residues which have, or will, be looked at are corn stover, cotton gin trash, sunflower stalks, and sorghum stalks. The SGFM reactor operates as a countercurrent, fluidized bed in which the solid feedstock is fed to the top of the reactor and fluidized by an upward flowing stream of air, steam, and product gases. This top feed system provides some advantages over conventional fluidized beds in that the incoming feedstock is partially dried by direct contact with hot product gases. In addition, the initial pyrolysis gases which are formed quickly exit the reactor zone and are quenched by the incoming cool solids. As a result, the product gas contains significant amounts of methane, ethane, and ethylene along with hydrogen, carbon monoxide, carbon dioxide, and nitrogen. The major results to date pertain to the gasification of wood. The reactor was operated over the temperature range of 500° to 800°C. Under these conditions the yields of product gas varied from about 16 SCF/lb daf to 20 SCF/lb daf. The higher heating value of the raw gas was 300 to 400 Btu/SCF. Preliminary results from corn stover gasification indicate that the gas yields from corn stalks will be very similar to those observed with wood. In both these cases, the gas yields are significantly higher than was seen with manure. An economic evaluation of the SGFM process using wood as the feedstock, indicates that for a 1000 ton per day plant, a medium-Btu fuel gas can be produced for approximately $3.30 per million Btu's, assuming wood chips delivered t the plant at $15 per ton.

9757 (SERI/TP—33-285, pp 351-357) **Catalytic gasification of biomass.** Mudge, L.K.; Sealock, L.J. Jr.; Robertus, R.J.; Mitchell, D.H.; Weber, S.L. (Pacific Northwest Lab., Richland, WA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Results of laboratory and process development unit (PDU) studies on gasification of biomass (wood) in the presence of catalysts are presented. Previous studies in this program have shown that alkali carbonates are effective catalysts for enhancing the steam gasification of wood. This paper reports on the use of an alkali carbonate catalyst in combination with commercial catalysts for the conversion of wood directly to a valuable gas product: methane or a synthesis gas. Laboratory investigations have shown that use of an alkali carbonate catalyst in combination with commercial methana-

tion and cracking catalysts gives a gas mixture with about 50 vol % methane and the remainder carbon dioxide. About 70% of the wood carbon is converted to gas. Operations in the PDU with the same catalysts, but different flow conditions, have given a gas mixture with about 25% methane. Operations are at atmospheric pressure and at temperatures from 450° to 700°. The PDU and laboratory investigations have shown that catalyst combinations can be used that give a synthesis gas directly from steam gasification of wood with over 90% of the wood carbon converted to gas. The synthesis gas has a 2 to 1 mole ratio of hydrogen to carbon monoxide with the remainder of the gas carbon dioxide and about 1 vol % methane.

9758 (SERI/TP—33-285, pp 393-400) **RefCOM (Refuse conversion to methane).** Ware, P.J. (Waste Management, Inc., Oak Brook, IL). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

In 1975, the US Department of Energy (formerly ERDA) awarded Waste Management, Inc. a contract to design and construct a proof-of-concept experimental facility to demonstrate the biological gasification of urban solid waste and sewage sludge to produce methane-rich gas. Named RefCOM, the facility will process between 50 and 100 tons per day of the organic fraction of shredded urban refuse. Jacobs Constructors, Inc., a subsidiary of Jacobs Engineering Company of Pasadena, California, was the engineering/construction management subcontractor for the project. Construction of the facility was completed by May 1st, 1978, and was followed by a six-month startup phase. The plant has been in daily operation since November, 1978, and is being run in accordance with a predetermined experimental program which will be of two-to-four years' duration. Waste Management, Inc. has been awarded an operating contract to manage the program and operate the facility. The Department of Energy (DOE), a successor agency of ERDA, has other programs underway which support the experimental program at Pompano Beach. These include mixing experiment comparing gas and mechanical agitation, methods for recovering energy from the resultant sludge material, and feedstock preparation by means of high pressure steam explosion. As information is developed in these ancillary projects, the experimental program at Pompano Beach may be modified.

9759 (SERI/TP—33-285, pp 401-410) **Design and evaluation of a methane gas system for a hog farm.** Turnacliff, W.; Custer, M.; Veatch, M.A. (Bio-Gas of Colorado, Inc., Arvada). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of the study was to determine the economic feasibility of constructing and operating anaerobic digestion systems on small hog farms. A 200-gallon (760 liter) pilot digester was operated on hog waste, but the volatile acids never stabilized and the run was terminated. The cause of the digestion failure appeared to be an antibiotic which is fed to the hogs as a control for swine dysentry. However, a farm system was sized to provide the equivalent of $300 per month of propane. The total required investment was $112,800 resulting in a gas production cost of $16.50 per million Btu ($15.64 per million kJ). To approach economic feasibility, a small farm anaerobic digestion system would have to be owner-built.

9760 (SERI/TP—33-285, pp 411-418) **Heat treatment of biomass for increasing biodegradability.** McCarty, P.L.; Young, L.; Owen, W.; Stuckey, D.; Colberg, P.J. (Stanford Univ., CA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Autohydrolysis of a white fir chip slurry from 150° to 225°C without oxygen and at an autogenic pH of 2.5 resulted in the partial hydrolysis of cellulosic components and an increase in anaerobic biodegradability to methane. Excessive temperature or time resulted in the formation of toxic materials and/or degradation of biodegradable materials into refractory residues. Staged autohydrolysis pretreatment for maximizing conversion of forest product residues to biodegradable materials offers a potential for conversion of 40% of the combustion energy into methane. Studies on biodegradation of products from thermochemcal treatment of lignin at pH 13 demonstrated that the lower molecular weight fractions and single-ring aromatic compounds are bioconvertible to methane. Studies on thermochemical pretreatment of nitrogenous materials indicate that while mild treatment increases biodegradability, the biodegradation of amino aicds, DNA and RNA are hindred through formation of refractory and toxic products. Conditions which minimize these adverse effects are being sought.

9761 (SERI/TP—33-285, pp 419-428) **Anaerobic fermentation of beef cattle and crop residues.** Hashimoto, A.G.; Chen, Y.R. (Dept. of Agriculture, Clay Center, NE). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

This report summarizes the research being conducted at the Roman L. Hruska US Meat Animal Research Center to assess the technical and economic feasibility of recovering methane and high protein biomass from the anaerobic fermentation of beef cattle and crop residue. To accomplish this objective, a pilot-scale fermentor was operated and an economic assessment was performed based on the pilot-scale results. The highest methane production rate (4.65 L CH_4/L fermentor.d) was produced at a retention time of 5 days, loading rate of 16.8 kg VS/m^3.d, hourly feeding, and fermentation temperature of 55°C. An economic assessment of the thermophilic, anaerobic fermentation process for beef feedlots was performed with various biogas handling and use options. Option A consisted of CO_2, H_2S and H_2O removal, compression, storage, and use in an internal combustion engine/generator to produce electricity with waste engine heat being used to heat the fermentor. Option B resembled A, except CO_2 was not removed from the biogas. Option C resembled Option B, except the biogas was not compressed or stored. Option D resembled B, except the biogas was used as fuel for a boiler, rather than used in an engine/generator. Option E resembled D, except the biogas was not compressed or stored. The fermentation plant size at which the electrical production costs equals the current rates of $12.50 per gigajoule (GJ) for electricity and $2.50/GH for natural gas would be 24, 54, 29, 91, and 36 megagrams of total solids per day (Mg TS/d) for Options A, B, C, D, and E, respectively. However, when a refeed credit of $60/Mg dried effluent is applied to this analysis, the plant size at which energy production costs equals current energy prices are 5, 6, 4, 5, and 3.5 Mg/d for Options A, B, C, D, and E, respectively.

9762 (SERI/TP—33-285, pp 429-436) **Operation of a 50,000 gallon anaerobic digester at the Monroe State Dairy Farm.** Coppinger, E.R. (Ecotope Group, Seattle, WA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

A full scale anaerobic digester on the State Dairy Farm has been operated and monitored for the past 22 months under funding from the US Department of Energy, Fuels from Biomass Systems Branch. During the period of its operation, a number of variables have been changed and the impact of those changes on digester performance are descirbed. The percent of the slurry loaded has been raised from 4% to 12%. In-tank mixing is by gas recirculation and has been decreased progressively from 24 hours per day to none at all. The only internal mixing at present is by convection currents caused as a byproduct of the digester heating system. Heating requirements have been reduced by tank insulation and reductions in make-up water added. A prototype tube-in-shell influent/effluent heat exchanger has been installed and tested. Based on the operational experience gained from the Monroe digester, design recommendations are presented.

9763 (SERI/TP—33-285, pp 439-443) **Conversion of forest residue to a methane-rich gas.** Feldmann, H.F.; Chauhan, S.P.; Liu, K.T.; Kim, B.C.; Choi, P.S.; Conkle, H.N. (Battelle Columbus Labs., OH). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objectives of this program are to reduce the cost of wood gasification to a gas that is suitable for either synthesis or a fuel gas that is interchangeable with natural gas. This will be accomplished by catalyses of the gasification reaction and developing a novel reactor system for biomass gasification. Promising catalyst candidates previously identified in bench-scale screening studies are wood ash and calcium oxide. These catalysts are now being studied in a continuous reactor system which simulates conditions in a commercial gasification system. Results of gasification experiments with pure hydrogen, hydrogen/steam mixtures and pure steam will be described. The novel multi-solid reactor system should allow significant economic benefits to be achieved by eliminating the oxygen required for gasification, minimizing front end feed preparation and increasing gasifier throughput. A pilot plant multi-solid gasifier is now being designed which will demonstrate these advantages. Preliminary economic feasibility studies reported previously indicate that wood gasification by this process should be cost competitive with other supplemental clean fuels.

9764 (SERI/TP—33-285, pp 445-449) **Conversion of biomass materials to gaseous products.** Garrett, D.E. (Garrett Energy Research & Engineering Co., Ojai, CA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The Garrett Energy Research & Engineering biomass gasification process is centered around a multiple hearth furnace of special design. The multiple hearth furnace was chosen because of its ability ot process difficult-to-handle materials - even materials that cannot be processed in conventional airblown biomass gasifiers. The stages of this multiple hearth furnace are as follows: biomass drying in a stream of hot flue gas, indirectly heated pyrolysis - the pyrolysis gas contains no N_2 - at elevated temperature, combustion of part of the pyrolytic carbon, and finally a water gas stage in which the remaining carbon is gasified in a steam/air atmosphere. When moist manure is fed to the pyrolysis hearth, a substantial part of the pyrolytic

carbon is gasified there. A mathematical model of the low temperature water gas reaction is presented and used to correlate some pilot plant data.

9765 (SERI/TP—33-285, pp 451-457) **Catalytic conversion of biomass to fuels.** Ushiba, K.K.; Mahawili, I.; Cooper, M.C.; Garten, R.L. (Catalytica Associates, Inc., Santa Clara, CA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

This study concerns a systematic assessment of the role of catalysis and new developments in catalytic reactor technology for the thermochemical conversion of biomass to gaseous and liquid fuels. In this report the physical and chemical properties of biomass are compared to coal as a basis for assessing the utility of coal conversion concepts for biomass. In addition, the role of catalysts in the steam gasification of carbon is examined with regard to the implications for gasification of biomass. Recent studies demonstrate that known catalysts (alkaline earths, Group VIII metals) for the carbon-steam do not increase reaction rates by a lowering of the activation energy but by increasing the concentration of catalytic sites in contact with the carbon source. Maintaining maximum contact between the carbon source and the catalyst throughout gasification is therefore necessary to achieve the greatest rate enhancement. This generally requires undesirably high catalyst concentrations which necessitates recovery and reprocessing of the catalyst. The most desirable catalyst is one which enhances the rate by lowering the activation energy and which could be utilized in low concentrations. Such materials have not been reported to date.

9766 (SERI/TP—33-285, pp 471-476) **Coal gasification technology: wood feedstock retrofit potential.** Keene, A.G.; Nyce, A.C. (Gorham International Inc., ME). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Gorham International Inc. undertook a study contract to determine which state-of-the-art and advanced coal gasifiers are technically and economically suitable for gasification of wood feedstocks. The primary study tasks are to (1) critically review patents and published literature, (2) conduct 40 to 50 in-depth on-site interviews with gasifier developers, users, and manufacturers, (3) obtain information on specific gasification technologies from over 200 firms and organizations, (4) collect prior art and operating data on wood gasification, (5) estimate operating cost, capital equipment costs, gas costs, and gasification rates for coal gasifiers operating on wood feedstocks, (6) identify advantages and disadvantages of using wood feedstocks, (7) evaluate the sensitivity of capital costs and product costs to plant size, (8) determine wood type, size, shape and moisture content most suitable for specific coal gasifiers, (9) identify barriers to implementation of wood gasification plants, and (10) develop implementation strategies. Gorham will deliver the following information in the final report: (1) discussion and assessment of the thrust of coal gasification technology, (2) specifications, schematics, and wood gasification rates for coal gasifiers modified for use with wood feedstocks, (3) specific modifications required to convert coal gasifiers for use with wood feedstocks, (4) comparative capital equipment costs, operating costs, and costs ($/mm Btu's) for low, medium, and high Btu gas and synthesis gas produced from coal and from wood feedstocks, (5) recommendations for wood feedstocks and wood feedstock preparation and handling equipment, (6) comparative costs for the materials of construction for coal and wood gasifiers, (7) wood gasifier implementation plan, (8) barriers to implementation plan and (9) alternative strategies to overcome these barriers.

9767 (SERI/TP—33-285, pp 548-580) **Low cost methane generation on small farms.** Jewell, W.J.; Dell'Orto, S.; Fanfoni, K.J.; Hayes, T.D.; Leuschner, A.P.; Sherman, D.F. (Cornell Univ., Ithaca, NY). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

This paper examines the effect of farm size on the technical and economic feasibility of methane generation. After the rationale is developed for considering small farm installation of anaerobic fermentors, the technical requirements and information needs to implement low cost biogas generation systems are identified. This report summarizes the small farm fermentor development program that has been on-going at Cornell University since 1974. The large majority of agricultural residues are generated on relatively small agricultural operations. For this reason, on-site generation and utilization of energy is assumed to be required in many cases. The potential of small farm methane generation is significant but it is essential that low-cost systems be developed. Laboratory, pilot scale, and full scale demonstration studies have identified a low-cost, easily constructed approach that may be cost-effective for operations as small as the 40-cow dairy. This system uses an unmixed plug flow design with the methane generation reactor constructed with soil supported rubber-like pond liner material. Full-scale operation for over a year, including the coldest New York winter, has shown that this unit is a feasible alternative. Finally, comparison of the total investment required for widespread adoption of methane generation technology to nuclear, fossil fuel, and massive installation of solar power indicates that it could be highly competitive. Equivalent installation costs for small methane generation systems are estimated to be $200 to $600 per kilowatt of energy generation capacity, whereas other sources vary from $300 to $6,000 per kilowatt of energy generation.

9768 **Gasification of solid waste fuels in a fixed bed gasifer.** Mudge, L.K.; Rohrmann, C.A. (Battelle Northwest, Richland, WA). *ACS Symp. Ser.;* **76**: 126-141(1978).

A gasification process is described where the waste is fed through a lock hopper into the top of a vertical, cylindrical retort through which it gravitates through zones of increasing temperature. The waste is dried and pyrolyzed to a char and the char is gasified and burned. The gas flow is countercurrent to that of the solids. An air steam blast at ~150° is fed into the retort through the grate into an ash zone that projects the grate and distributes the gas over the cross section. Tests were carried out in pilot plant facilities with a 1- and 3-ft diameter reactors. The feed materials were municipal refuse, wood wastes (chips, shavings), agricultural residues (corn stalks, grass straw), tires, and simulated nuclear wastes.

ALCOHOL FUELS

REFER ALSO TO CITATION(S) 9576

PREPARATION

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 9570, 9571, 9572, 9573

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 9751, 9843, 9845, 9846, 9849, 9851, 9852, 9853, 9856, 9857, 10605

9769 (PB—292552) **The production of ethanol from agricultural waste-an economic evaluation. Final report.** Paige, D.; Boulton, R. (California Univ., Davis (USA)). Jan 1979. 31p. NTIS PC A03/MF A01.

Cannery wastes are the most economical feedstock for producing fuel-grade ethanol based on the criteria of: (1) cost of collection; (2) content of fermentable substances; (3) value for other uses; (4) cost of present disposal methods; (5) perishability; (6) length of season available; and (7) byproduct value. The quantities of wet waste (vegetable and fruit waste from processing plants and canneries) and dry waste (crop residues, straw) available in California are estimated. Economic analyses based on investment rate of return are developed for four alternate process schemes, varying in complexity from a simple pretreatment, fermentation, and distillation process to a process involving pretreatment, enzymatic hydrolysis, concentration, aerobic ethanol fermentation, aerobic cellobiose fermentation and distillation. The hypothesized schemes use tomato and peach cannery wastes and/or rice straw as feedstocks. The economic sensitivity to plant size, ethanol market price, and waste treatment credit is shown. Annual investment rates of return of from 7 to 12 percent are calculated. Quantitative studies are recommended to determine the actual amount of waste feedstock available, and details of process conditions.

9770 (SERI/SP—451-519) **Fuel from farms: a guide to small-scale ethanol production.** (Solar Energy Research Inst., Golden, CO (USA)). Feb 1980. Contract EG-77-C-01-4042. 165p. Dep. NTIS, PC $5.75/MF $3.50.

A guide on fermentation processes with emphasis on small-scale production of ethanol using farm crops as a source of raw material is published. The current status of on-farm ethanol production as well as an overview of some of the technical and economic factors is presented. Decision and planning worksheets and a sample business plan for use in decision making are included. Specifics in production including information on the raw materials, system components, and operational requirements are also provided. Diagrams of fermentors and distilling apparatus are included. (DC)

9771 (SERI/TP—33-285, pp 69-75) **Production of liquid fuels from cellulosic biomass.** Pye, E.K.; Humphrey, A.E. (Univ. of Pennsylvania, PA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

A novel, elevated temperature process for the total conversion of cellulosic biomass to liquid fuels has been devised and shown to be technically feasible by our research group. It has several unique features which allow reduced process energy costs in the simultaneous production of two liquid fuels - ethanol for use as a

gasoline extender and octane enhancer, and a butanol/lignin slurry for use as a pumpable furnace or diesel fuel. The process relies on a hot aqueous butanol pretreatment of the biomass to yield an enzyme-degradable cellulose fraction, a high quality polymer-grade lignin fraction, a partially degraded hemicellulose fraction for fermentation to butanol, and a butanol/lignin slurry for use as a fuel. The cellulose is fermented to ethanol either by an elevated temperature (~ 60°C) simultaneous saccharification/vacuum fermentation step using cellulase from Thermoactinomyces, and the anaerobic bacterium C. thermocellum; or by hydrolyzing it to a high glucose syrup (> 20%) with Thermoactinomyces cellulase for use in a standard yeast fermentation. The process is currently being tested and optimized with wood chips from fast growing poplar trees, but it also appears attractive for conversion of municipal solid waste and agricultural residues. Production costs for ethanol appear to be about 70 to 80 cent/gallon, depending on biomass costs, yields and byproduct credits.

9772 (SERI/TP—33-285, pp 255-264) **Liquid fuel and chemical production from cellulosic biomass: hemicellulose recovery and pentose utilization in a biomass processing complex.** Chambers, R.P.; Lee, Y.Y.; McCaskey, T.A. (Auburn Univ., AL). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objectives and research program tasks include the following: (1) develop a selective acid hydrolysis process suitable for large scale applications which can selectively extract and recover the hemicellulose portion of biomass in the form of its constituent sugars (primarily xylose); (2) to utilize this hemicellulose recovery process as a pretreatment process for cellulose hydrolysis - the solids from which the hemicellulose has been removed have a much higher susceptibility to cellulose hydrolysis; (3) to experimentally screen and isolate microorganisms that can ferment the xylose-rich acid hydrolyzate with good yields to liquid fuel constituents, chemical by-products and fuel intermediates; (4) to develop a process for the conversion of acid hydrolyzate sugars to fuels, by-product chemicals and fuel intermediates; and (5) to coordinate the processes described above with the remaining processes under study elsewhere in order to develop an integrated biomass refining complex.

9773 (SERI/TP—33-285, pp 275-280) **Bioconversion of plant biomass to ethanol.** Brooks, R.; Su, T.M.; Brennan, M.; Frick, J. (General Electric Corp., Schenectady, NY). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The General Electric Corporate Research and Development (GE/CRD) process employs low pressure chemically augmented hardwood steaming and rapid decompression to produce a readily digestible substrate. A mixed culture of Clostridum thermocellum and Clostridum thermosaccharolyticum ferments the pretreated wood at 60°C directly to ethanol. C. thermocellum is used primarily to solubilize cellulose and to convert cellobiose to ethanol. Co-culture with C. thermosaccharolyticum enhances the rate of cellulose degradation and permits the xylose produced during pretreatment to also be fermented to ethanol. Product recovery is accomplished via continuous withdrawal of the fermentation broth to a separate vacuum distillation chamber (modified vacuferm) and subsequent distillation to produce 95% ethanol. After ethanol separation, the cell mass is returned to the fermentor to maintain cell density while lignin is discharged, partially dried, and used to fuel the pretreatment boiler. If practical, spent silage is recovered and used as fertilizer. The preliminary ethanol cost analysis is encouraging; however, pretreatment optimization and improvements in the overall mixed culture ethanol tolerance and yield is required before larger scale process evaluation is justified.

9774 (SERI/TP—33-285, pp 281-289) **Enzymatic saccharification of waste cellulose.** Mandels, M. (US Army Natick Research and Development Command, MA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective is to develop a practical process for the conversion of cellulose in biomass to ethanol, a liquid fuel, via enzymatic conversion of cellulose and yeast fermentation of glucose. The process can be divided into five steps: (1) selection of a suitable substrate; (2) pretreatment of the substrate to enhance its enzyme susceptibility; (3) production of active cellulase; (4) utilization of the cellulase to saccharify cellulose; and, (5) fermentation of saccharification syrups to ethanol. The principal contributions of Natick have been in defining the basic microbiology and biochemistry of the process, particularly the identification of Trichoderma reesei as the best source of active cellulase, the realization that cellulase is a complex of enzymes that act synergistically with each other, and the demonstration of rapid extensive saccharification of many cellulosic materials with Trichoderma cellulase. Cellulase production has been increased by mutation of the strain and optimization of the fermentation. The effficiency of the cellulase has been increased by addition of supplemental β glucosidase from Aspergillus phoenicis. Various pretreatments including chemical, high pressure steam, and various types of milling increase substrate susceptibility. Enzyme has been produced at pilot plant scale (400 liters) at high titre (15 g soluble protein per liter of broth) and productivity (85 filter paper cellulase units per liter per hour). Saccharification by Trichoderma cellulase plus Aspergillus β glucosidase has been advantageously coupled with yeast fermentation to ethanol, resulting in greater conversion than in the uncoupled system and preventing contamination of the saccharification reactor without addition of toxic or inhibitory chemicals.

9775 (SERI/TP—33-285, pp 477-487) **Biomass based methanol processes.** Wan, E.I.; Simmons, J.A.; Price, J.D.; Nguyen, T.D. (Science Applications, Inc., McLean, VA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The three major components of the bimass to methanol system are the availability of biomass feedstocks, the thermochemical conversion of biomass to methanol fuels, and the distribution and market analysis of methanol fuels. Initial efforts were undertaken to identify and evaluate the regional potential of biomass resources and to asses the market for methanol fuels. Three commercially available oxygen-blown gasification processes were analyzed and compared in terms of their feasibilities for producing methanol synthesis gas from biomass. These processes include the fixed bed Wellman-Galusha and Purox gasifiers, and the entrained-bed Koppers-Totzek gasifier. Two commercially available methanol synthesis processes plus one advanced liquid-phase methanol system were also analyzed. Empirical and theoretical process models were developed so that parametric analysis and economic sensitivity can be determined. An optimized process design based on 1000 tpd biomass throughput has been derived. Detailed material and energy information of this base design were used for economic sensitivity analysis. The results of this study have indicated that currently the cost of methanol production from biomass ranges from 60 to 90 cents per gallon depending upon regional feedstock costs, the conversion plant size, the gasification process employed, and overall process energy integration and optimization. In order to achieve higher conversion efficiency and competitive economics, several alternative biomass to methanol production concepts were formulated. This involved the incorporation of an advanced biomass gasification concept, simplification of synthesis gas modification processes, optimization of methanol synthesis, and the adapation of hybrid synthesis gas schemes.

9776 (SERI/TP—33-285, pp 515-546) **Conceptual design of a biomass fermentation facility.** O'Neil, D.J.; Bery, M.K.; Colcord, A.R.; Roberts, R.S.; Sondhi, D. (Georgia Inst. of Tech., Atlanta). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

This report summarizes the initial results of Phase I of a planned multi-year program sponsored by the US Department of Energy. The overall objective is the design, construction, and operation of a three oven-dry ton per day process development unit (PDU) to demonstrate the economic and technical feasibility of producing anhydrous ethanol from lignocellulosic biomass residues (wood, corn stover, wheat straw, principally). The report specifically focuses on a proposed conceptual design for the PDU. It discusses biomass cost and availability in addition to unit operations: (1) pretreatment, (2) hydrolysis, (3) fermentation, (4) alcohol recovery, (5) by-product utilization, and (6) environmental monitoring. Results of a process optimization and sensitivity analysis for dilute acid hydrolysis are included.

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 9857, 10037, 10038, 10307, 10600

9777 (N—79-18424) **Identification of wood energy resources in central michigan.** Hudson, W.D.; Kittleson, K. (Michigan State Univ., East Lansing (USA)). Nov 1978. Contract NGL-23-004-083. 37p. NTIS PC A03/MF A01.

Existing biomass studies were compiled for determining their applicability in measuring forest biomass in an entirely new way. Over sixty tree-weight tables were prepared from existing tables or formulas. An estimate of forest biomass was made on a defined area by using LANDSAT Satelite data analysis, existing forest cover type maps and actual weighting of the entire biomass. Control plots were cruised for normal volume data and weight data, harvested and weighed to determine actual tonnage yields.

HYDRO ENERGY

REFER ALSO TO CITATION(S) 10035

RESOURCES AND AVAILABILITY

9778 (EMD—80-30) **Hydropower: an energy source whose time has come again.** Staats, E.B. (General Accounting Office, Washington, DC (USA)). 11 Jan 1980. 96p. General Accounting Office, 441 G St., NW, Washington, DC.

Report to the Congress of the United States by the Comptroller General.

The remaining hydropower potential in the USA is analyzed. Studies indicate that the potential, particularly at existing dam sites, can save the country hundred of thousands of barrels of oil per day. Economic, environmental, institutional, and operational constraints limit its full potential. These problems are investigated and recommendations are made on measures the Federal government can take to encourage development of this resource.

SOLAR ENERGY

9779 (AD-A—066221) **Digest of equipment for converting solar, wind, and geothermal energy into electric power for USN application ashore. Final report, May 1977-March 1978.** Lorman, W.R. (Civil Engineering Lab. (Navy), Port Hueneme, CA (USA)). Nov 1978. 103p. NTIS, PC A06/MF A01.

This document enumerates principal requirements of self-sufficient electric power conversional equipment under active consideration by CEL. Data pertain to financial requirements, physical characteristics, and potential outputs of solar, wind, and geothermal energy conversion systems; these systems are part of USN shore energy research and development program. Data are intended for use by CEL systems analysts as input to mathematical model for planning and optimizing power systems throughout the Naval Shore Establishment.

9780 (PB—293063) **Illinois solar energy directory.** Green, B.D.; Pogany, D.Z. (Illinois Inst. of Natural Resources, Springfield (USA)). Nov 1978. 107p. NTIS PC A06/MF A01.

This Directory contains a listing of Illinois and nationwide solar energy equipment manufacturers, distributors, installers, and consultants. Discussions of consumer protection and solar law in Illinois are included. A bibliography and listing of available resources and a catalogue of Illinois solar installations are included.

9781 (WAOENG—79-5) **Catalogue of Washington State Model Solar Programs.** (Washington State Energy Office, Olympia (USA)). Sep 1979. 58p. Washington State Energy Office, Olympia, WA.

The programs included are educational programs, community development efforts, farm efforts, legislative efforts, financing programs, and commercial and business programs. (MHR)

RESOURCES AND AVAILABILITY

REFER ALSO TO CITATION(S) 9995

9782 (DOE/CS/4131—1(Vol.2), pp 39-45) **Standards for solar energy applications.** Carlson, J.M.; Riley, J.D. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Issues, trends, and activities in the field of standards for solar energy applications are described. The following questions are discussed: (1) how pressing is the need for a consistent set of national standards for solar energy applications; (2) what are the roles of the traditional framework and the federal government in meeting the needs; (3) is acceleration of the development process wise; and (4) what are the impacts of standards on the solar community and on solar technology development. (WHK)

9783 (DOE/NASA/20485—79/6) **Global calibration of terrestrial reference cells and errors involved in using different irradiance monitoring techniques.** Curtis, H.B. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). 1979. Contract EX-76-A-29-1022. 13p. (NASA-TM—81393; CONF-800106—5). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

Experiments have shown that global calibration of terrestrial reference cells is feasible provided reasonable constraints on irradiance and incident sun angle are used. There is significantly less dependence of the calibration value on atmospheric composition in the global method compared to the collimated technique. A simple, accurate secondary calibration technique based on ratios of test to reference cell currents measured in natural sunlight was developed. Studies and experiments have been performed to determine relative merits and errors involved in using different techniques for monitoring incident irradiance during solar cell performance measurements. The techniques of black-body detectors, calibrated reference cells, and the convolution of spectral response with solar irradiance are considered. The second is the most accurate technique.

9784 **Sun angles for design.** Bennett, R. Washington, DC; American Institute of Architects (1978). 79p. American Inst. of Architects, 1735 New York Ave., NW, Washington, DC 20006.

A design aid is presented which shows sun angle data in an intuitively understandable and usable form. Charts simulate the sun's motion across the sky and show its position for any time of day and any day of the year. (MHR)

ECONOMICS

REFER ALSO TO CITATION(S) 9939

9785 (PB—292891) **The future of solar energy in California.** (Haldi Associates, Inc., New York (USA)). 30 Nov 1977. 180p. NTIS PC A09/MF A01.

The topics include general problems dealing with the development and marketing of solar energy systems.

ENVIRONMENTAL, LEGAL, AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 9816, 9978, 10596

9786 (NP—24102) **Solar energy policy.** (Community Services Administration, Washington, DC (USA)). Jan 1979. 47p. Community Services Administration, Washington, DC.

This Solar Energy Policy document enunciates a comprehensive set of energy policies which reflect the Community Services Administration's (CSA's) legislative mandate to assist the poor with energy-related matters. Part I first describes the Agency Mission then, more specifically: (1) the energy-related problems of the poor and near-poor, including their lack of funds with which to pay sharply increasing utility bills; (2) the decline in health and deterioration in living conditions when increasing numbers of families have to choose between food and energy; and (3) in the cases of the elderly and the handicapped, a challenge to survival. Part I concludes with a description of CSA energy-related policy goals. Part II sets forth detailed and specific CSA solar energy policies, including the following: energy conservation/optimal weatherization; solar retrofit; publicly-subsidized and privately-owned rental housing; new single-family construction; rural solar development (biomass, hydro, wind); low-cost technologies; training and jobs; small business; standards, warranties, and licensing; solar tax incentives, low-interest loans, and grants; and inter-Agency coordination. (MCW)

9787 **Solar tax credit regulations. Final committee report.** Sacramento, CA; California Energy Commission (1979). 5p. (NP—24159).

This Final Committee Report, together with the Interim Committee Report and the attached set of proposed regulations, constitute recommendations of the Solar Implementation and Coordination Committee to the California Energy Commission for the implementation of AB 3623. These recommendations will be considered for action at the Commission's July 11, 1979 business meeting in Sacramento.

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

REFER ALSO TO CITATION(S) 9893, 9898, 9998

9788 (AD-A—066385) **Performance of photovoltaic cells in an undersea environment. Final report, March-October 1978.** Stachiw, J.D. (Naval Ocean Systems Center, San Diego, CA (USA)). 1 Jan 1979. 44p. NTIS, PC A03/MF A01.

Photovoltaic solar cells can serve as a reliable source of electric power for electronic instrumentation in temporarily or permanently submerged marine systems in the form of bottom installations, buoys, or remotely controlled unmanned vehicles. The power output of submerged solar cells is a function of solar insolation intensity on the water surface, depth of sumbersion, optical properties of water, temperature, and the orientation of the cell surface with respect to the sun. Experimental data were generated by submerging solar cell panels in different bodies of water with a 2.5- to 95-ft visual contrast limit, as defined by the observation of a

submerged, standard, 12-in Secchi disc, and measuring their performance under load. The power output of horizontally oriented, upward-facing, photovoltaic cells submerged to the visual contrast limit depth was found to be a constant, equal to approximately 5 to 10 percent of the power generated by upward-facing, horizontally oriented cells in an atmospheric environment. The power output of the cells increased at lesser depths, until in the spash zone the output was essentially the same or higher than in the atmospheric environment. Based on these findings it can be concluded that high-efficiency silicon solar cells can serve as a practical electrical power supply in electronic devices for marine applications, if their depth of submersion in less than the visual contrast limit at the dive location.

9789 (COO—4726-10) **Cuprous oxide photovoltaic cells. Final report, January 1, 1978-September 30, 1978.** Trivich, D.; Wang, E.Y.; Komp, R.J. (Wayne State Univ., Detroit, MI (USA)). Oct 1978. Contract ET-78-S-02-4726. 52p. Dep. NTIS, PC A04/MF A01.

Cuprous oxide, with a band gap of 2.0 eV, is a potentially useful material for photovoltaic cells because of low cost and high availability. Previous work on Schottky barrier Cu_2O cells indicated that the low efficiency of 1% could be due to chemical degradation of the junction. Interlayers could be useful in restraining this reaction and could lead to improved cells. In this research using Auger and ESCA surface analysis methods, it was found that copper metal was present at the junction in Al/Cu_2O cells thus supporting the hypothesis of a chemical reaction between the Al and the Cu_2O. MIS cells with interlayers of SiO_2, Sb_2O_3 and Si_3N_4 showed some dependence of V/sub oc/ on the work function of the metal but AlO/sub x/ interlayers, produced by evaporation of Al in O_2, suffered the chemical degradation, presumably due to incomplete conversion to Al_2O_3 in the preparation. The resistivity of Cu_2O can be reduced by annealing at 500° (rho ~ 100 to 200 Ω cm), by doping of Cu with Cd before oxidation to Cu_2O (rho ~ 150 Ω cm), by zone refining and annealing (rho = 36 Ω cm) and by doping of Cu_2O melts with CdO (rho = 9 Ω cm).

9790 (DOE/JPL/1012—27) **Low-Cost Solar Array Project. Progress report 12, January-April 1979 and proceedings of the 12th Project Integration Meeting.** (Jet Propulsion Lab., Pasadena, CA (USA)). 1979. Contract EX-76-A-29-1012. 344p. Dep. NTIS, PC A15/MF A01.

This report describes progress made by the Low-Cost Solar Array Project during the period January through April 1979. It includes reports on project analysis and integration; technology development in silicon material, large-area sheet silicon, and encapsulation; production process and equipment development; engineering and operations, and a discussion of the steps taken to integrate these efforts. It includes a report on, and copies of viewgraphs presented at the Project Integration Meeting held April 4-5, 1979.

9791 (DOE/JPL/1012—34) **Characterization of deliberately nickel-doped silicon wafers and solar cells. JPL Publication 79-116.** Salama, A.M. (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Nov 1979. Contract EX-76-A-29-1012. 26p. Dep. NTIS, PC A03/MF A01.

Microstructural and electrical evaluation tests were performed on nickel-doped p-type silicon wafers before and after solar cell fabrication. The concentration levels of nickel in silicon were 5 x 10^{14}, 4 x 10^{16}, and 8 x 10^{18} atoms/cm^3. It was found that nickel precipitated out during the growth process in all three ingots. Clumps of precipitates, some of which exhibited star shape, were present at different depths. If the clumps are distributed at depths ~ 20 μm apart and if they are larger than 10 μm in diameter, degradation occurs in solar cell electrical properties and cell conversion efficiency. The larger the size of the precipitate clump, the greater the degradation in solar cell efficiency. A large grain boundary around the cell effective area acted as a gettering center for the precipitates and impurities and caused improvement in solar cell efficiency. Details of the evaluation test results are given.

9792 (DOE/JPL/954355—9) **Large area silicon sheet by EFG. First quarterly report, January 1, 1979-March 31, 1979.** Wald, F.V. (Mobil Tyco Solar Energy Corp., Waltham, MA (USA)). 15 Apr 1979. Contract NAS-7-100-954355. 85p. Dep. NTIS, PC A05/MF A01.

In growth station JPL No. 1 the work during this quarter centered around trying to evaluate any influences on ribbon quality which might be caused by various materials of construction which are used in the growth furnace. At the present level of ribbon quality, which has produced 8.5% to 9.5% efficient solar cells, no particular influence of any furnace part was detected. The experiments rather led to the suspicion that the general environment and the somewhat unoptimized materials handling procedures might be responsible for the current variations in ribbon quality and that, therefore, continuous work with this furnace under rather more stringent environmental conditions and operating procedures could perhaps improve materials quality to some extent. The work on Machine 3A (the multiple furnace) was continued with two multiple growth runs being performed. In these runs, the melt replenishment system performed poorly and extensive modifications to it have been designed to make reliable melt feeding for five ribbon growth possible. Although in the first quality assessment runs ever performed with the melt replenishment system diffusion lengths nearly as great as those found in non-melt replenished runs were found, we have not yet apparently identified all the factors affecting SiC density in ribbons grown from this large volume furnace. Thus, cell performance on multiple ribbon has not yet been demonstrated. The 10 cm width growth cartridge was also completely constructed during this quarter and will be checked out as soon as the multiple runs have been completed. Also, certain new characterization techniques for wide ribbons as well as on stress measurements and growth dynamics experiments are reported, the latter being a necessary precursor to the design of automatic control techniques.

9793 (DOE/JPL/954373—10) **Silicon ingot casting - heat exchanger method multi-wire slicing - fixed abrasive slicing technique, Phase III. Silicon sheet growth development for the large area sheet task of the Low-Cost Solar Array Project. Quarterly progress report No. 2, January 1-March 31, 1979 .** Schmid, F.; Khattak, C. (Crystal Systems, Inc., Salem, MA (USA)). Apr 1979. Contract NAS-7-100-954373. 40p. Dep. NTIS, PC A03/MF A01.

Several 20 cm diameter silicon ingots, up to 6.3 kg, have been cast with good crystallinity. It has been found that the graphite heat zone can be purified by heating it to high temperatures in vacuum. This is important in reducing costs and purification of large parts. Electroplated wires with 45 μm synthetic diamonds and 30 μm natural diamonds have shown good cutting efficiency and lifetime. During slicing of a 10 cm x 10 cm workpiece, jerky motion occurred in the feed and rocking mechanisms. This problem is being corrected and at the same time modifications are being made to reduce the weight of the bladehead by 50%.

9794 (DOE/JPL/954373—11) **Silicon ingot casting - heat exchanger method multi-wire slicing - fixed abrasive slicing technique, Phase III. Silicon sheet growth development for the large area sheet task of the Low-Cost Solar Array Project. Quarterly progress report No. 3, April 1-June 30, 1979. .** Schmid, F.; Khattak, C.P. (Crystal Systems, Inc., Salem, MA (USA)). Jul 1979. Contract NAS-7-100-954373. 36p. Dep. NTIS, PC A03/MF A01.

Ingot casting has been scaled up to 16 cm x 16 cm square cross-section size weighing up to 8.1 kg. The high degree of crystallinity has been maintained in the large ingot. For large sizes, the nonuniformity of heat treatment causes chipping of the surface of the ingot. Significant effort and progress have been made in the development of a uniform graded structure in the silica crucibles. The high speed slicer has been modified so that the blade-head weight is reduced to 37 lb. This has allowed higher surface speeds of up to 500 fpm. Slicing of 10 cm diameter workpieces at these speeds has increased the throughput of the machine to 5.7 mils/min, 0.145 mm/min, 50% more than the projected cutting rates used in the economic analysis.

9795 (DOE/JPL/954376—8) **Laser-zone growth in a ribbon-to-ribbon (RTR) process silicon sheet growth development for the large area silicon sheet task of the Low Cost Solar Array Project. Technical quarterly report No. 9, October 1-December 31, 1978. Motorola Report No. 2256/12.** Baghdadi, A; Gurtler, R.W.; Legge, R.; Sopori, B.; Rice, M.J.; Ellis, R.J. (Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group). 1978. Contract NAS-7-100-954376. 27p. Dep. NTIS, PC A03/MF A01.

Breakthroughs were achieved in two areas critical to the RTR process. A series of flat polycrystalline ribbons measuring 5 cm x 61 cm was grown and successfully separated from 24" long Mo substrates. Solar cells on gettered RTR silicon were grown from pre-etched (≅ 1/2 mil) CVD feedstock. The best cell had a conversion efficiency of 10.6%, with V/sub oc/ = 0.565 volts, I/sub sc/ = 29.8 ma/cm^2, and a fill factor of 63%. The low fill factor does indicate that still higher efficiencies can be attained on this material by improving the processing sequence. The economic analysis for the overall RTR process has been updated in response to technological progress. The total price for the overall process, including feedstock, was projected at $19 to $23/m^2, assuming multiple ribbon growth.

9796 (DOE/JPL/954376—9) **Laser-zone growth in a ribbon-to-ribbon (RTR) process silicon sheet growth development for the large area silicon sheet task of the Low Cost Solar Array Project. Technical quarterly report No. 10, January 1-March 31, 1979.** Baghdadi, A.; Gurtler, R.W.; Legge, R.; Sopori, B.; Rice, M.J.; Ellis, R.J. (Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group). 1979. Contract NAS-7-100-954376. 32p. Dep. NTIS, PC A03/MF A01.

This quarter has witnessed appreciable progress in achieving high efficiency on RTR solar cells, with an average efficiency of 9.1% on the most recent lot. The best cell to date has a measured efficiency of 11.3%. A new technique for growing limited-length ribbons continually has been demonstrated. This Rigid Edge technique can be used to recrystallize about 95% of the polyribbon feedstock. A major advantage of this method is that only a single,

constant length silicon ribbon is handled throughout the entire process sequence; this may be accomplished using cassettes similar to those presently in use for processing Czochralski wafers. Thus a transition from Cz to ribbon technology can be smoothly affected. The maximum size being considered, 3" x 24", is half a square foot and will generate 6 watts for 12% efficiency at 1 sun. Silicon dioxide has been demonstrated as an effective, practical diffusion barrier for use during the polyribbon formation. Two different approaches for using the silicon dioxide are being pursued.

9797 (DOE/JPL/954654—6) **Silicon web process development. Low Cost Solar Array Project, Large Area Silicon Sheet Task. Quarterly report, October 1, 1978-December 31, 1978.** Duncan, C.S.; Seidensticker, R.G.; Hopkins, R.H.; McHugh, J.P.; Hill, F.E.; Heimlich, M.E.; Driggers, J.M. (Westinghouse Research and Development Center, Pittsburgh, PA (USA)). 1978. Contract NAS-7-100-954654. 117p. Dep. NTIS, PC A06/MF A01.

Silicon dendritic web is a ribbon form of single crystal silicon produced directly from the melt without the use of dies or shapers. Solar cells fabricated on web have exhibited conversion efficiencies of 15.5% - the highest yet for a ribbon form of silicon. The primary objectives of this program are to develop techniques to grow silicon web at 25 cm^2/min output rate and demonstrate the feasibility of web growth with simultaneous melt replenishment. The methods developed are to be compatible with efficient solar cell performance. During this quarter the focal points of the effort have been: (1) tests of aftertrimmers to improve web width; (2) evaluation of growth lid designs to raise speed and output rate; (3) tests of melt replenishment hardware; and (4) investigation of directed gas flow systems to control unwanted oxide deposition in the system and to improve convective cooling of the web. Technical progress is reported in detail. (WHK)

9798 (DOE/JPL/954796—4) **Analysis and evaluation of processes and equipment in Tasks II and IV of the Low-Cost Solar Array Project. Quarterly report, April-July 1978.** Goldman, H.; Wolf, M. (Pennsylvania Univ., Philadelphia (USA). Moore School of Electrical Engineering). Nov 1978. Contract NAS-7-100-954796. 219p. Dep. NTIS, PC A15/MF A01.

The significant economic data for the current production multiblade wafering and inner diameter slicing processes were tabulated and compared to data on the experimental and projected Varian multiblade slurry, STC ID diamond coated blade, Yasunaga multiwire slurry and Crystal Systems fixed abrasive multiwire slicing methods. Cost calculations were performed for current production processes and for 1982 and 1986 projected wafering techniques.

9799 (DOE/JPL/955089—3) **Silicon solar cell process development, fabrication and analysis. Third quarterly report, January 1-March 31, 1979.** Yoo, H.I.; Iles, P.A.; Tanner, D.P. (Optical Coating Lab., Inc., City of Industry, CA (USA). Photoelectronics Div.). 1979. Contract NAS-7-100-955089. 75p. Dep. NTIS, PC A04/MF A01.

The objective of this program is to investigate, develop, and utilize technologies appropriate and necessary for improving the efficiency of solar cells made from various unconventional silicon sheets. Work has progressed in fabrication and characterization of solar cells from cast silicon by heat exchanger method (Crystal Systems), EFG (RH) ribbon (Mobil Tyco) and silicon on ceramic (Honeywell). Silicon blanks (2 x 2 cm) were prepared from the HEM cast silicon and EFG ribbon, using conventional slicing techniques, and fabricated using a standard process typical of those used currently in the silicon solar cell industry. Also a back surface field (BSF) process and other process modifications were included in processing additional slices. Relatively large area (about 15 cm^2) solar cells were fabricated from silicon on ceramic substrates using a standard process that can be easily adapted to these substrates. Evaluation of the SOC solar cells has not been completed in this reporting period. The performance parameters measured included open circuit voltage, short circuit current, curve fill factor, and conversion efficiency (all taken under AMO illumination). Also measured for typical cells were spectral response, dark I-V characteristics, minority carrier diffusion length, and photoresponse by fine light scanning. The results were compared to the properties of cells made from the conventional single crystalline Czochralski silicon with an emphasis on statistical evaluation. Limited efforts were made to identify defects which will influence solar cell performance.

9800 (DOE/JPL/955269—1) **Low-cost solar array project: Task I, silicon material. Gaseous melt replenishment system. First quarterly progress report, 17 April-17 July 1979.** Jewett, D.N.; Bates, H.E.; Hill, D.M. (Energy Materials Corp., Harvard, MA (USA)). 1979. Contract NAS-7-100-955269. 25p. Dep. NTIS, PC A02/MF A01.

This program was initiated in April of this year to develop a system to combine silicon formation, by hydrogen reduction of trichlorosilane, with the capability to replenish a crystal growth system. The silicon formation system is based on a resistance heated quartz reaction vessel in which reduction of trichlorosilane deposits silicon on the walls of the vessel. After sufficient deposition has occurred, the silicon will be melted out of the reaction vessel and carried to the crystal growth system by a heated quartz delivery tube. Isolation of the reaction vessel during the silicon formation stage will be accomplished by a quartz U-tube trap-type valve containing silicon which can be melted to allow passage of molten silicon, or solidified to prevent passage of reactant gases. During the quarterly reporting period, a variety of process parameters were estimated to allow sizing and specification of gas handling system components. Most of the major components of the system have been designed, or specified, and ordered.

9801 (DOE/JPL/955324—1) **Development of a method of producing etch resistant wax patterns on solar cells. Quarterly technical report No. 1, January 17-March 31, 1979. Motorola report No. 2365/1.** Pastirik, E. (Motorola, Inc., Phoenix, AZ (USA). Semiconductor Group). 1979. Contract NAS-7-100-955324. 12p. Dep. NTIS, PC A02/MF A01.

Results produced during the first quarter of a one-year program to investigate the production of patterned etch resistant wax coatings on solar cell substrates by printing are described. Master molds for printing plates have been produced for the plates. The resist wax is being studied to determine its relevant physical properties. A printing device is currently in design, and material costs are being compiled as a first step in a cost analysis task. (WHK)

9802 (DSE—1459-T1) **Cadmium sulfide/copper sulfide heterojunction cell research. Technical progress report, February 26-May 31, 1979.** Anderson, W.W. (Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab.). Jun 1979. Contract EG-77-C-03-1459. 20p. (LMSC-D—676741). Dep. NTIS, PC A02/MF A01.

All vacuum deposition process Au/Cu_2S/Cd/sub 1-x/Zn/sub x/S/Nb photovoltaic cells have been fabricated by sequentially sputtering (1) Nb in Ar, (2) Cd/sub 1-x/Zn/sub x/, and then (3) Cu in H_2S and Ar gas mixtures, and finally, in a separate operation, (4) Au in Ar. Photovoltaic response of as-deposited junctions (i.e., without subsequent heat treatment) is obtained with appropriate deposition parameters. Resistivity of CdS or $Cd_{0.9}Zn_{0.1}S$ films is controlled by sputtering from In-doped metal cathodes. Junction characteristics are strongly influenced by deep trap levels on the Cd/sub 1-x/Zn/sub x/S side of the heterojunction. A trap level at E/sub t/ approx. = 0.37 eV below the conduction band edge has been identified in sputter deposited CdS by admittance spectroscopy.

9803 (DSE—3412-T1) **Photovoltaic mechanisms in polycrystalline thins-film solar cells. Quarterly technical progress report No. 1, September 27-December 27, 1978.** Zanio, K. (Hughes Research Labs., Malibu, CA (USA)). Jun 1979. Contract ET-78-C-01-3412. 26p. Dep. NTIS, PC A03/MF A01.

Preliminary studies were initiated to examine and alleviate the deleterious effect of grain boundaries in solar cells fabricated from InP. The planar reactive deposition system was modified so that the InP substrate temperature could be reduced below the single crystalline to polycrystalline transition temperature and effects of grain boundaries on p-n junctions can be more readily and reproducibly separated out. A model for grain boundaries intersecting a p-n junction was introduced. In the model, the grain boundary is treated as a two-dimensional array of lower bandgap material which enhances the leakage current at the p-n junction. The effect of various etchants on grain boundaries in InP was also examined as a preliminary step toward passivating the grain boundaries. An anodic oxide and InGaP, both candidates as passivation layers, were deposited on single-crystal InP.

9804 (N—78-78104) **GaAs solar cell development. Quarterly report No. 1, 25 April-25 July 1978.** (Hughes Research Labs., Malibu, CA (USA)). Jul 1978. 9p. NTIS, PC A02/MF A01.

The objective of this program is to optimize the (AlGa)As-GaAs solar cells being fabricated at HRL for radiation damage. Three sets of GaAs cells will be fabricated during the course of the program and subjected to 1 MeV irradiation at JPL. These cells will be studied for radiation damage and recovery by temperature anneals up to 250 degrees C. During the last quarter the authors have been experimenting with gradual changes in the fabrication schedule for the epitaxial structure to enable them to reduce the junction depth to below 0.5 micrometers. Such a step has been shown desirable during their past studies on radiation damage in GaAs cells. Cells with these characteristics are now being fabricated and the first set of these will be delivered to JPL in about two weeks.

9805 (N—79-17898) **Earth orbital assessment of solar electric and solar sail propulsion systems.** Teeter, R.R. (Battelle Columbus Labs., OH (USA)). 30 Sep 1977. Contract NASW-2018. 78p. NTIS PC A05/MF A01.

The earth orbital applications potential of Solar Electric (Ion Drive) and Solar Sail low-thrust propulsion systems are evaluated. Emphasis is placed on mission application in the 1980s. The two low-thrust systems are compared with each other and with two

chemical propulsion Shuttle upper stages (the IUS and SSUS) expected to be available in the 1980s. The results indicate limited Earth orbital application potential for the low-thrust systems in the 1980s (primarily due to cost disadvantages). The longer term potential is viewed as more promising. Of the two systems, the Ion Drive exhibits better performance and appears to have better overall application potential.

9806 (N—79-18451) **Phase 1 of the automated array assembly task of the low cost silicon solar array project. Final report.** Pryor, R.A.; Grenon, L.A.; Coleman, M.G. (Motorola, Inc., Phoenix, AZ (USA)). Jan 1978. Contracts NAS7-100;JPL-954363. 300p. NTIS PC A13/MF A01.

The results of a study of process variables and solar cell variables are presented. Interactions between variables and their effects upon control ranges of the variables are identified. The results of a cost analysis for manufacturing solar cells are discussed. The cost analysis includes a sensitivity analysis of a number of cost factors.

9807 (PNL-SA—7531) **Materials resource requirements and potential limitations in solar energy products.** Watts, R.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 21p. (CONF-790213—7). Dep. NTIS, PC A02/MF A01.

From 6. energy technology conference and exposition; Washington, DC, USA (26 Feb 1979).

A systematic methodology is discussed that can aid energy technology managers in identifying future material pinch points. This methodology is used to examine 15 photovoltaic, 9 Solar Heating and Cooling of Buildings (SHACOB) and 3 Agriculture and Process Heat (AIPH) systems. The results indicate that many photovoltaic systems have no serious materials constraints. However, definite availability constraints exist for indium, gallium and germanium in some photovoltaic systems and, therefore, material management strategies will be required for the large scale implementation of these systems. No serious material availability problems are identified in the SHACOB or AIPH systems, although several materials should be monitored closely in the future.

9808 (SAN—2207-T3) **Thin film polycrystalline silicon solar cells. Quarterly report No. 2, 1 January 1979-30 March 1979.** Sarma, K.R.; Rice, M.J.; Legge, R.; Ramsey, W.C. (Motorola, Inc., Phoenix, AZ (USA). Solar Energy Dept.). 1979. Contract ET-78-C-03-2207. 34p. Dep. NTIS, PC A03/MF A01.

A composite substrate concept was developed and shear separation successfully demonstrated. This substrate consists of a main molybdenum substrate, a thin (~ 1 μm) SiO_2 barrier layer and a thin (~ 3000A) Mo layer. The thin Mo layer gets converted to $MoSi_2$ and acts as a shear separation layer. This composite substrate shows promise for substantial improvement in recyclability and the quality of silicon ribbons produced. Effects of $SiHCl_3$ concentration, total reactant flow rate, beam rf power, substrate temperature and gravity on energy beam deposition were investigated. The deposition efficiency was found to be a strong function of input chlorosilane concentration. Rotating nozzle deposition was also studied. Problems were encountered in the use of the rotating nozzle due to improper impedance matching with the nozzle assembly. This required redesign of the rotating assembly to improve impedance matching. EBD silicon ribbons were grain enhanced by RTR recrystallization and successfully gettered by a two sided phosphorous diffusion which resulted in diffusion lengths ranging up to 75 μm. Solar cells, 1 x 2 cm in area were fabricated on these silicon ribbons; they exhibited conversion efficiencies of up to 10.1% with a V/sub OC/ of 0.54V, J/sub SC/ of 29.5 mA/cm² and a FF of 63%.

9809 (SAND—79-2445C) **Active and passive cooling for concentrating photovoltaic arrays.** Edenburn, M.W. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 12p. (CONF-800106—3). Dep. NTIS, PC A02/MF A01.

From 14. photovoltaics specialists conference; San Diego, CA, USA (7 Jan 1980).

The optimization, based on minimum energy cost, of active and passive cooling designs for point-focus Fresnel lens photovoltaic arrays and line-focus, parabolic-trough photovoltaic arrays are discussed, and the two types of cooling are compared. Passive cooling is more cost effective than active for Fresnel lens arrays while the reverse is true for parabolic trough arrays. The analysis produced several other conclusions of interest which are also discussed.

9810 (SERI/TP—311-428) **Proceedings: photovoltaic advanced R & D annual review meeting.** (Solar Energy Research Inst., Golden, CO (USA)). 1979. Contract EG-77-C-01-4042. 483p. (CONF-791025—). Dep. NTIS, PC A21/MF A01.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

Twenty-five of the twenty-seven papers were entered into the data base separately; two papers were previously included. (WHK)

9811 (SERI/TP—311-428, pp 1-11) **DOE/PV overview.** Prince, M.B. (Dept. of Energy, Washington, DC). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9812 (SERI/TP—311-428, pp 59-61) **Research program of the SERI Photovoltaics Branch.** Wagner, S. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9813 (SERI/TP—311-428, pp 63-68) **Overview of the SERI Photovoltaic Program Office subcontract activity.** Burke, J.R. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9814 (SERI/TP—311-428, pp 69-112) **Photovoltaic Program Office amorphous silicon/materials program overview.** Stone, J.; Sabisky, E.; Mahan, H. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9815 (SERI/TP—311-428, pp 113-119) **Amorphous silicon cell development.** Carlson, D.E. (RCA Labs., Princeton, NJ). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9816 (SERI/TP—311-428, pp 151-166) **Material resources and environmental studies.** Nagy, S. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9817 (SERI/TP—311-428, pp 167-194) **Cadmium sulfide based solar cells.** Deb., S.; Haines, W. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9818 (SERI/TP—311-428, pp 195-207) **Critical properties of the Cu_2S/CdS interface.** Haines, B. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

Although the CdS/Cu_2S cell has been studied for 25 years, many questions concerning its photovoltaic properties remain unanswered. The processing of CdS/Cu_2S cells has seemed like a black art, with various heat treatments and processing steps quoted as being essential to producing good cells. Recent investigations to probe the nature of the Cu_2S/CdS interface which show promise for understanding the details of photovoltaic operation for these devices are briefly discussed. Three areas that need better understanding are (1) the sensitivity of the cell to the spectral content of light, (2) the effects of heat treatment on the photovoltaic reponse, and (3) the mechanisms responsible for degradation of the cell. (WHK)

9819 (SERI/TP—311-428, pp 209-232) **SERI annual R & D review: LSA project activities presentation.** Callaghan, W.T. (Jet Propulsion Lab., Pasadena, CA). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9820 (SERI/TP—311-428, pp 233-270) **Polycrystalline silicon colar cells.** Surek, T. (Solar Energy Research Inst., Golden CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9821 (SERI/TP—311-428, pp 271-285) **Characterization of grain boundaries in solar cell materials.** Kazmerski, L.L. (Solar Energy Research Inst., Golden CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

Grain boundaries in multigrained Si and polycrystalline GaAs are characterized using surface analytical techniques. Complementary Auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS) and x-ray photoelectron spectroscopy (XPS) are used in conjunction with in-situ, ultrahigh vacuum fracturing to examine the chemistry of the grain boundaries. Scanning Auger microprobe (SAM) and electron beam induced current (EBIC) techniques are used to electrically analyze the same regions characterized compositionally by the surface analysis methods. These results are correlated, and indications of the importance of grain boundary chemistry on solar cell performance are provided.

9822 (SERI/TP—311-428, pp 295-315) **Thin film gallium arsenide solar cells.** Benner, J. (Solar Energy Research Inst., Golden CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9823 (SERI/TP—311-428, pp 317-324) **Low-cost, high-efficiency GaAs solar cells.** Fan, J.C.C. (Massachusetts Inst. of Tech., Lexington). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9824 (SERI/TP—311-428, pp 325-327) **Status of photovoltaic concentrator development.** Schueler, D.G. (Sandia Lab., Albuquerque, NM). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9825 (SERI/TP—311-428, pp 329-351) **Multijunction concentrators.** Mitchell, K.W. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9826 (SERI/TP—311-428, pp 353-373) **Luminescent solar concentrators.** Benner, J. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9827 (SERI/TP—311-428, pp 375-385) **Materials for high efficiency monolithic multigap concentrator solar cells.** Ludowise, M.J.; Bell, R.L.; Cooper, C.B.; James, L.W.; Moon, R.L.; Vander Plas, H.A. (Varian Associates, Palo Alto, CA). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9828 (SERI/TP—311-428, pp 387-415) **Emerging materials summary.** Mitchell, K.W. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9829 (SERI/TP—311-428, pp 417-422) **Photovoltaic phenomena in polyacetylene, (CH)/sub x/.** Heeger, A.J.; MacDiarmid, A.G. (Univ. of Pennsylvania, Philadelphia). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9830 (SERI/TP—311-428, pp 423-439) **Thin film cadmium telluride solar cells.** Chu, T.L.; Chu, S.S.; Pauleau, M.Y.; Stokes, E.D. (Southern Methodist Univ., Dallas, TX). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

Cadmium telluride is a direct gap semiconductor with a room temperature band gap energy of 1.5 eV. Solar cells made from cadmium telluride have higher theoretical conversion efficiency than those from silicon, gallium arsenide, and other semiconductors. The deposition of cadmium telluride films and the fabrication of thin film solar cells have been under investigation for many years. The most commonly used method for the deposition of cadmium telluride films is the evaporation of the compound or the elements under a pressure of 10^{-4} to 10^{-9} Torr. Other techniques developed for the deposition of cadmium telluride films include chemical transport and sublimation in an inert atmosphere. The objective of this work is to investigate the chemical vapor deposition of cadmium telluride films on low cost substrates and the preparation of thin film cadmium telluride solar cells. The preliminary results are presented. (WHK)

9831 (SERI/TP—311-428, pp 441-449) **Photovoltaic array cost: efficiency tradeoffs.** Schueler, D.G. (Sandia Lab., Albuquerque, NM). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9832 **Theory of the electrical and photovoltaic properties of polycrystalline silicon.** Ghosh, A.K.; Fishman, C.; Feng, T. (Exxon Research and Engineering Co., Linden, New Jersey 07036). *J. Appl. Phys.;* **51**: No. 1, 446-454(Jan 1980).

Grain boundary states play a dominant role in determining the electrical and photovoltaic properties of polycrystalline silicon by acting as traps and recombination centers. The recombination loss at grain boundaries is the predominant loss mechanism in polycrystalline solar cells. Cell parameters are calculated based on a transformation of grain boundary recombination centers to a uniform distribution of such states throughout the grain. Effective carrier lifetime is expressed in terms of grain size, allowing calculation of short-circuit current, open-circuit voltage, and fill factor. Excellent agreement is observed between theory and experiment for almost all device parameters. It is indicated that one could fabricate 10% efficiency polycrystalline solar cells from 20-μm-thick material if the grain size exceeds 500 μm.

9833 **Simulations of the transient photoconductivity in a-SiO_2 using a multiple-trap model.** Schaffman, M.; Silver, M.; Corthell, C.; Hughes, R.C. (Department of Physics and Astronomy, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina 27514). *J. Appl. Phys.;* **51**: No. 1, 490-494(Jan 1980).

Computer simulations for transient photocurrent produced by a uniform excitation in a system with an exponential distribution of traps have been performed, and the results have been compared with recent experimental data of the transient photoconductivity in SiO_2 and found to show excellent agreement. The temperature dependence of the parameters of our multiple-trap model are discussed with reference to the experimental results, providing further support for the application of this model to a-SiO_2.

9834 **Thermal degradation of indium-tin-oxide/p-silicon solar cells.** Goodnick, S.M.; Wager, J.F.; Wilmsen, C.W. (Department of Electrical Engineering, Colorado State University, Fort Collins, Colorado 80523). *J. Appl. Phys.;* **51**: No. 1, 527-531(Jan 1980).

Thermal degradation of indium-tin-oxide (ITO)/p-silicon solar cells has been investigated for cells fabricated on both single and polycrystalline silicon. The primary thermal degradation mechanisms was found to be the growth of SiO_2 at the ITO/silicon interface resulting from oxygen diffusion through the ITO and not decomposition of the ITO. The degradation rate appears to be limited by surface reaction controlled oxidation since this rate is independent of ITO thickness. The polycrystalline cells were observed to degrade somewhat faster than the single-crystalline cells. The projected cell life at 50 °C due to thermal failure mechanisms exceeds 10^5 years for both single-crystal and polycrystalline cells.

9835 **Inverted amorphous silicon solar cell utilizing cermet layers.** Hanak, J.J. (to RCA Corp.). US Patent 4,162,505. 24 Jul 1979. Filed date 24 Apr 1978. 6p.

A hydrogenated amorphous silicon solar cell is described which incorporated a transparent high work function metal cermet on the body of hydrogenated amorphous silicon indicent to solar radiation. A thick metal cermet opposite to the incident surface forms a back electrode. A brief review is presented of the electric propoerties of solar cells and the problems encountered in the efficient production of amorphous silicon solar cells. (SPH)

9836 **Method of forming solar cell with discontinuous junction.** Lindmayer, J. (to Solarex Corp.). US Patent 4,162,177. 24 Jul 1979. Filed date 6 Mar 1978. 6p.

A solar cell is described which has a back junction that is discontinuous, i.e., one that has shorted portions rather than a continuous layer of metal. By covering less than one half of the back surface with junction - forming metal, it was found that the cell will generate sufficient voltage to frickle charge a battery and be substantially unaffected by increases in light impinging on the front surface of the cell. The method of forming such a silicon solar cell and their features and advantages are discussed. (SPH)

9837 **Solar cell array.** Kaplow, R.; Frank, R.I. (to Massachusetts Inst. of Tech.). US Patent 4,162,174. 24 Jul 1979. Filed date 10 Mar 1978. 12p.

A semiconductor solar-cell array is described which includes a plurality of adjacent solar cell segments, each segment comprising a number of series-connected unit solar cells, and the series connected unit solar cells from each segment being electrically connected in parallel with the series-connected unit solar cells from other segments. Concentrated solar radiation is focused on the upper surface of the solar-cell array wherein the periphery of the focused image is contained within the upper surface area. The series-parallel connection of the unit solar cells and solar cell segments provides maximum utilization of incident solar radiation to thereby increase solar cell output. In addition, the series-parallel connection scheme allows the array to operate effectively without imposing stringent requirements as to solar-tracking precision in order to maintain the focused image at a fixed location on the upper surface of the cell.

9838 **High bandgap window layer for GaAs solar cells and fabrication process therefor.** Kamath, G.S. (to Hughes Aircraft Co.). US Patent 4,156,310. 29 May 1979. Filed date 17 Mar 1978. 6p.

The specification describes a semiconductor solar cell and fabrication process therefor wherein a thin N-type gallium arsenide layer is deposited on a larger P-type substrate layer which is selected from the group of III-V ternary compounds consisting of aluminum phosphide antimonide, AlPSb, and aluminum indium phosphide, AlInP. P-type impurities are diffused from the substrate layer into a portion of the thin N-type gallium arsenide layer to form P-type region wherein which defines a PN junction in the thin gallium arsenide layer. Thus, the quantity of gallium arsenide required to provide this PN photovoltaic junction layer in the cell is minimized, and th P-type substrate serves as a high bandgap window layer for the cell. Such high bandgap of this window material is especially well suited for efficiently transmitting the blue spectrum of sunlight to the PN junction, thus enhancing the power conversion efficiency of the solar cell.

THERMIONIC AND THERMOELECTRIC CONVERSION

REFER ALSO TO CITATION(S) 9995

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 9576, 9749, 9750, 9752, 9753, 9754, 9755, 9756, 9757, 9758, 9759, 9760, 9761, 9762, 9763, 9764, 9765, 9766, 9767, 9768, 9770, 9771, 9772, 9773, 9774, 9775, 9776, 9777, 10037, 10038, 10290, 10598, 10599, 10600, 10601, 10605, 10637, 10638, 10645, 10646, 10647, 10648, 10649, 10650, 10651, 10652

9839 (COO—5022-8) **Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Monthly technical progress report, August 1, 1979-September 30, 1979.** Stringer, R.P.; Bailie, R.C. (Gilbert Associates, Inc., Reading, PA (USA); West Virginia Univ., Morgantown (USA); Environmental Energy Engineering, Inc., Morgantown, WV (USA)). 1979. Contract ET-78-C-02-5022. 17p. Dep. NTIS, PC A02/MF A01.

The scope of the project is described in the Clarification Proposal which was sent to DOE on March 29, 1978. In that proposal, 15 tasks were designed to develop a linear programming model which will enable the energy manager to determine the most profitable mix of biomass resources and conversion processes to produce the desired fuel. The project includes a market analysis of the need for biomass derived fuels, and the regional availability of biomass resources on seasonal bases. Secondly, it includes development of biomass conversion profiles for 100 biomass materials including wood species, bagasse, sugar cane, wheat and rice straw, corn stover, and others. Conversion profiles will be developed from Thermal Gravimetric Analyses runs under various conditions of temperature and pressure and in the presence of catalysts. Gasification, pyrolysis, and direct combustion shall be the modes of conversion. An attempt will be made to develop biomass-to-fuel process models and to verify them using process development unit runs. Finally, a linear programming model shall be developed for selecting the most profitable combination of feedstocks and the conversion processes required to satisfy fuels need under given market conditions. The data banks of market conditions for biomass resources and biomass derived fuels, biomass conversion profiles, and commercial scale process economics will be used as input to the model. Progress on reaching these goals and a summary of findings are reported.

9840 (COO—5022-9) **Research and evaluation of biomass resources/conversion/utilization systems (market/experimental analysis for development of a data base for a fuels from biomass model). Quarterly technical progress report, August 1, 1979-October 31, 1979.** Ahn, Y.K.; Chen, Y.C.; Chen, H.C.; Nelson, E.T.; Stringer, R.P. (Gilbert Associates, Inc., Reading, PA (USA); West Virginia Univ., Morgantown (USA); Environmental Energy Engineering, Inc., Morgantown, WV (USA)). 1979. Contract ET-78-C-02-5022. 35p. Dep. NTIS, PC A03/MF A01.

Market analyses information now stored in the biomass feedstock data base includes for each species: feedstock amount by region and season in tons/year; heating values in Btu/lb for those feedstock for which published data are available, and; feedstock cost in $/mm Btu. Information now stored in the product data base includes for each product: product amount by region in mm Btu/year and product cost in $/mm Btu. Biomass characterization procedures have now been developed and these will be used to characterize approximately 100 biomass species. TGA analyses will be supplemented with a pyrogram and a pyrochromatogram to further characterize each biomass. Tests were run on the PDU in the fluidized bed mode to determine the effects of particle size on reaction time. Thirteen tests were run during this quarter to verify the results from previous testing. The PDU is being modified to accommodate future sustained runs. Allocation modeling program is now functional and being tested as data is provided to the feedstock and product data banks. A mathematical model has been developed by modifying the Texaco Entrained Bed Pilot Plant Gasifier Model to simulate biomass gasification in an Entrained Bed. Results are being evaluated. Models for other reaction modes are being evaluated. A biomass economic program has been developed to provide average product fuel costs using 15 thermochemical processes.

9841 (DSD—91-1) **Estimating the cost of wood-generated electricity: a broader perspective.** Segerson, K.T. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). Jul 1978. 17p. Dartmouth College, Hanover, NH.

The cost of wood-generated electricity is dependent upon a number of economic and environmental factors, many of which are uncertain by nature and difficult to predict. A report of the cost of wood-generated electricity by Allan J. Schultz for the Vermont Public Service Board (Schultz 1977) recognizes these uncertainties, but does not adequately account for them in its cost projections. Schultz's analysis is extended here to include the full range of values these projections could take. A number of statewide benefits are explored which might be provided Vermont by a wood-fired plant -- employment of state residents, increases in tax income, and several nonquantifiable factors. In an attempt to show how these benefits might be credited back to the plant to reduce its operating expenses, two mechanisms are introduced, transfer payments and public financing, that could bring the cost of wood-fired power down to levels competitive with other fuels. The conclusion is that, while there is a great degree of uncertainty in estimating the cost of electricity generated with wood, it is possible and desirable to assign a range of possible future costs to this power. The best analysis shows that, over at least part of this range, wood-generated electricity is cost competitive.

9842 (DSD—101) **Environmental impact of harvesting noncommercial wood for energy: research problems.** High, C.J.; Knight, S.E. (Dartmouth Coll., Hanover, NH (USA). Thayer School of Engineering). Oct 1977. 13p. Dartmouth College, Hanover, NH.

This is a preliminary report for discussion embodying some findings of analyses undertaken at the Thayer School of Engineering. These were conducted as part of a feasibility study for a 50-megawatt wood-fired power plant in Vermont and in preparation for an environmental impact assessment of a wood-fired electric/steam congeneration facility now in the planning phase for a site in Maine. The major research problems associated with the environmental impact of harvesting wood for electric power generation and industrial energy are highlighted.

9843 (JPL-PUB—79-9) **Bioconversion study conducted by JPL.** (Jet Propulsion Lab., Pasadena, CA (USA)). 15 Nov 1978. 115p. Jet Propulsion Lab, Pasadena, CA.

The Jet Propulsion Laboratory of the California Institute of Technology conducted a study of bioconversion as a means of identifying the role of biomass for meeting the nation's energy fuel and chemical requirements and the role and means for JPL-Caltech involvement in bioconversion. The study was directed and carried out by an interdisciplinary group of JPL and Caltech scientists and engineers and included a comprehensive review of the state of biomass technology through an extensive review of literature sources, and interviews with organizations and authorities active in the field of bioconversion. The bioconversion study included the following categories: biomass sources, chemicals from biomass, thermochemical conversion of biomass to fuels, biological conversion of biomass to fuels and chemicals, and basic bioconversion sciences. General conclusions of the study were that biomass promises to be a significant alternate energy source and that JPL-Caltech have an important role in this technology. A detailed review is included of the bioconversion fields cited with specific conclusions and recommendations for future research and development and overall biomass system engineering and economic studies.

9844 **Northeastern Forest Experiment Station.** Sarles, R.L. Broomall, PA; Forest Service (1979). 4p.

Biomass estimators applied to West Virginia timber resource data indicate that 34 million tons of wood is potentially available for fuel each year. This tonnage is the annual forest growth in excess of that now harvested for roundwood products. One-half of this excess can supply more than all of the state's energy needs in the residential and commercial sectors, or 44% in the industrial sector.

9845 (SERI/TP—33-285) **3rd annual biomass energy systems conference.** (Solar Energy Research Inst., Golden, CO (USA)). Oct 1979. Contract EG-77-C-01-4042. 625p. (CONF-790638—). Dep. NTIS, PC A99/MF A01.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The main objectives of the 3rd Annual Biomass Energy Systems Conference were (1) to review the latest research findings in the clean fuels from biomass field, (2) to summarize the present engineering and economic status of Biomass Energy Systems, (3) to encourage interaction and information exchange among people working or interested in the field, and (4) to identify and discuss existing problems relating to ongoing research and explore opportunities for future research. Abstracts for each paper presented were edited separately. (DC)

9846 (SERI/TP—33-285, pp 9-11) **SERI and the Biomass Program.** Smith, C.S. (Solar Energy Research Inst., Golden, CO). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The development of biomass as a resource base for fuels and energy saving chemicals will require the identification of appropriate supply, conversion technology, and product applications for commercialization. Biomass does not presently enjoy a suitable technology base. SERI is presently developing the staff and facilities necessary to conduct analyses, selected technology research and development, and commercialization assistance on biomass options. SERI is also providing Technical Program Management for the aquatic

production, anaerobic digestion and fermentation components of DOE's Biomass Energy Systems Program

9847 (SERI/TP—33-285, pp 13-23) **Biomass production by marine and freshwater plants.** Ryther, J.H. (Woods Hole, Oceanographic Inst., MA); Williams, L.D.; Hanisak, M.D.; Stenberg, R.W.; DeBusk, T.A. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Studies were continued during 1977 to 1978 on the growth and yields in culture of the red seaweed Gracilaria tikvahiae. Partial control of epiphytes was achieved by nutrient removal, shading, and/or biological agents. For the first time, a single clone of the alga was grown continuously throughout the year without replacement. Yields in large (2600 liter) aluminum tanks averaged 21.4 g dry wt/m^2.day, equivalent to 31 tons/acre.year. Yields of the freshwater macrophytes Lemna minor (common duckweed), Eichhornia crassipes (water hyacinth) and Hydrilla verticillata have also now been measured throughout the year with mean yields of 3.7, 24.2 and 4.2 g dry wt/m^2.day (5.4, 35.3 and 6.1 dry tons/acre.year) respectively. Yields of duckweed and water hyacinths in the cultured units have averaged roughly three times those of the same species growing in highly eutrophic natural environments.

9848 (SERI/TP—33-285, pp 33-37) **Biological investigations of marine farms (for biomass production).** Barcelona, M.; Gerard, V.; Kuwabara, J.; Lieberman, S.; Manley, S.; North, W. (California Inst. of Tech., Pasadena). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The project seeks to develop a methodology for producing plant biomass in surface oceanic environments far from shore. Research thus far has primarily utilized giant kelp, Macrocystis. Macrocystis grows naturally near the outer edge of the littoral zone, it can be coppiced, and has been harvested mechanically for decades in California. The earliest field studies demonstrated that Macrocystis grew poorly in offshore surface water due to scarcity of nutrients such as phosphorus and nitrogen. A proper balance of trace metals is also important. Seawater from 1000 or more feet deep is rich in nutrients and proved superior to enriched surface water in supporting kelp growth. Elementary requirements of Macrocystis and amounts needed of the most critical micro-nutrients were also investigated.

9849 (SERI/TP—33-285, pp 39-46) **Membrane processes of separation and concentration in biomass harvesting, production and refining.** Gregor, H.P. (Columbia Univ., New York, NY). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

New developments in the application of membrane technologies to biomass production, harvesting, and refining are summarized, including the use of ultrafiltration to harvest microscopic algae and single cell protein, to concentrate suspended and dissolved solids in corn refining, and to remove and concentrate the constituents of beer and stillage resulting from the fermentation of corn and molasses to ethanol. Research activities involving the use of new membranes for other biomass-related applications are described and include: the use of alcohol-selective membrane permeation systems for the removal of ethanol from a recirculating beer; the use of comparable water-selective membranes to enrich distillates from 80% to 99.5% ethanol; the use of tight anion-selective electrodialysis membranes to remove concentrated HCl from acid-sugar mixtures to allow for the low-cost reuse and recycle of that acid in the conversion of cellulose to sugars. Because membrane systems consume little energy and are highly efficient in effecting separation and concentration processes important in many phases of biomass conversion systems, it is anticipated that their applicability will prove significant in the overall effort.

9850 (SERI/TP—33-285, pp 53-58) **Fuels from microalgae.** Benemann, J.R. (Univ. of California, Berkeley). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Two microalgal systems for the production of fuels were studied: methane fermentations of sewage-grown microalgal biomass and biophotolysis, using blue-green algae. Although microalgal ponds have been used in wastewater treatment for several decades, the high cost of harvesting microalgae is limiting the applications of sewage oxidation ponds. A novel, low-cost process for microalgal harvesting, based on bioflocculation in a batch setting pond, has been demonstrated over the past year at the pilot quarter-acre (0.1 hectare) scale using a shallow, paddle wheel-mixed pond. It appears that such a process can meet both the requirements of wastewater treatment, that is, an average 85% removal of suspended algal solids and of low-cost microalgal biomass production. The key technical problems in designing large-scale microalgal biomass systems for fuels-chemicals production are discussed. The production of hydrogen from water by nitrogen-fixing heterocystous blue-green algae has been demonstrated in both the laboratory and with an outdoor converter; the relative advantages of alternative biophotosynthesis systems are considered.

9851 (SERI/TP—33-285, pp 59-60) **Fuels from fermentation of biomass.** Bungay, H.R. (Rensselaer Polytechnic Inst., Troy, NY). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The fermentation of biomass as a commercial energy source technology is discussed. Areas that have progressed to the point of commercialization are presented. These are programs financed by DOE contracts. The costs of production are also discussed. It was concluded that the rapid rate of progression makes it likely that production of alcohol fuels and petrochemical substitutes from biomass can soon become a very large scale operation in the United States.

9852 (SERI/TP—33-285, pp 91-95) **Acid hydrolysis of cellulosic biomass.** Converse, A.O.; Grethlein, H.E. (Dartmouth Coll., Hanover, NH). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

A continuous plug flow reactor was built for acid hydrolysis of cellulosic materials. A single pass hydrolysis at 240°C with 1% acid gives 50 to 57% glucose yield for a slurry concentration of 5 to 13.5% solids. Glucose and xylose yield maps are developed that indicate the trade off of product, by-product, and unreacted product. For high xylose recovery, a two-stage hydrolysis is needed, the first stage at low temperature (180 to 200°C) and the second at high temperature (230 to 240°C). Furfural recovery from xylose may lead to important by-product credits. The flow reactor has also been used to give acid pretreatments to cellulosic materials prior to enzymatic hydrolysis. The yield increase by enzymatic hydrolysis is significant for oak (21% to 90%), corn stover (58% to 100%), and newsprint (60% to 93%) as a result of the pretreatment. Thus, a combination of acid hydrolysis pretreatment with enzymatic hydrolysis can achieve nearly quantitative yields of glucose. Estimates of the cost of ethanol from newsprint and wood are given for one-pass acid hydrolysis, enzymatic hydrolysis, and the combination of the two.

9853 (SERI/TP—33-285, pp 111-117) **Modified extruder for feeding cellulosic slurries to pressure systems.** White, D.H. (Univ. of Arizona, Tucson). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective is to evaluate through experimental tests whether a modified screw extruder (as used in the food and plastics industry) could be used to feed a finely-ground slurry (ground sawdust in heavy oils or water) into a pressure reactor system. This is of direct interest for the DOE Waste-to-Oil pilot plant, Albany, Oregon and the DOE-sponsored cellulosics gasification work at Ballston Spa, New York. This basic overall goal was achieved during the first year of the contract in 1978, utilizing Albany, Oregon process facility sawdust, giving results of, (a) pumped feed slurries in extruder developing up to 8,500 psi pressure head, whereas 3,000 psi needed, and (b) pumped up to 70 wt % feed slurries, whereas pilot facility piston pumps are limited to 25 to 30 wt % sawdust. During 1979, scaleup factors are being determined, which involve extruder design, extruder operation conditions, properties of sawdust feed and properties of the necessary carrier oil. The work to date has been successful using single screw extruders. Later in 1979 or 1980, field tests will be conducted upon several alternative types of extruders.

9854 (SERI/TP—33-285, pp 123-129) **Bench scale research in biomass liquefaction in support of the Albany, Oregon, experimental facility.** Elliott, D.C.; Giacoletto, G.M. (Battelle Memorial Inst., Richland, WA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objectives of this project are to determine through bench scale investigation process changes required to facilitate fuel oil production by the CO-Steam process at the Albany Biomass Liquefaction Experimental Facility; provide routine and specialized analytical support for the facility operators; and determine process feasibility on a bench scale of new biomass liquefaction techniques which may be appropriate for development at Albany. The work has been based on the use of a batch autoclave wherein biomass is converted in an oil slurry. During the past year the work has dealt with catalyst concentration, catalyst addition technique, substitution of hydrogen donor solvents for the slurry oil, and comparison of different feedstock reactivities. Extensive use has been made of analytical instruments to provide both routine and specialized analysis of the Albany products and feedstocks. Development work for a new biomass liquefaction technique based on thermolysis of biomass in a continuously varying solvent system being subcontracted.

9855 (SERI/TP—33-285, pp 459-469) **Research and evaluation of biomass resources/conversion/utilization systems.** Ahn, Y.K. (Gil-

bert Associates, Inc., Reading, PA); Brumberg, R.J.; Chen, H.T.; Nelson, E.T.; Stringer, R.P.; Bailie, R.C. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of the project is to develop a linear programming model to inform the regional energy planner of the most profitable biomass resources and conversion facilities available to satisfy specific fuel needs. To produce this model, data will be generated on representative biomass feedstocks; market analyses of biomass resources and commercial fuel needs; and economics of thermochemical conversion facilities. Thermochemical conversion profiles will be generated from representative biomass materials. The profiles will be developed from Thermal Gravimetric Analyzer (TGA) runs under various conditions of temperature, pressure, and particle size and in the presence of catalysts. Gasification, pyrolysis, and direct combustion will be the modes of conversion. The biomass thermochemical conversion profiles will be used to develop biomass-to-fuels process models. These models will be verified using a Process Development Unit for a series of runs. During the initial phase of the two-year project, the linear programming model has been developed, biomass materials selected, and standard procedures for the TGA analysis developed.

9856 (SERI/TP—33-285, pp 581-587) **Biological production of liquid fuels from biomass. Summary report.** Humphrey, A.E. (Univ. of Pennsylvania, Philadelphia); Nolan, E.J. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The purpose of this Summary is to describe past, present, and proposed technologies for the biological production of liquid fuels and chemical feedstocks from biomass raw materials and to assess their potential for contributing to the national energy supply. The biomass raw materials of interest can be grouped into four categoires, i.e., (1) cereal grain starches, (2) sugar from cane and other similar agricultural crops, (3) cellulose from agricultural residues and municipal wastes, and (4) wood. The fuel under consideration is ethanol derived by fermentation processes. the Summary comprises three major considerations: (1) economic analysis of existing process technologies and estimation of alcohol production costs of these processes translated into mid-1978 costs; (2) comparison of processes based on present and envisioned technological developments; and (3) technological challenges and breakthroughs needed to make the production of alcohol from biomass economically and energetically attractive.

9857 **Wood processing, forestry, and agricultural wastes.** Zerbe, J.I. (Forest Service, Madison, WI). pp 181-192 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

Wood processing wastes are being used more and more as fuel within the forest products industries, particularly the pulp and paper industry. This industry has grown from 38 percent energy self-sufficiency to about 46 percent energy self-sufficiency since the 1973 OPEC oil crisis. Nonetheless, there are still close to 20 million dry tons of unused wood waste generated at plants each year. Forestry wastes are an important resource that will find increasing use for fuel. In total, there are 485 million dry tons per year available from all processing, forestry, and urban wood wastes. If only half of these could be captured economically, at costs of $30 to $40 per ovendry ton, the contribution to our energy needs could be a total of 4.1 quadrillion Btu's (quads). Added to the 1.1 quads that come from wood now, this would provide 7 percent of our total energy consumption. Agricultural wastes, including plant processing wastes, field wastes, and manure, could add significantly to the total. This paper is concerned mainly with wood wastes converted to energy through direct burning, liquefaction, and gasification. Direct burning of biomass wastes is projected to be the most used technology in the United States in the near term, but gasification can fill important needs with further development. Liquefaction, although important in countries such as Brazil and New Zealand, is not expected to find wide application in the United States soon.

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

REFER ALSO TO CITATION(S) 9744, 9995

9858 (SERI/TP—311-428, pp 121-145) **Electrochemial photovoltaic cells.** Deb, S.; Wallace, W. (Solar Energy Research Inst., Golden, CO). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9859 (SERI/TP—311-428, pp 147-150) **State of the art AgAs photoelectrochemical solar cells.** Parkinson, B.A. (Ames Lab., IA). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9860 **Experimental work on a CdO-based solar cycle for water splitting.** Pangborn, J.B. Chicago, IL; Institute of Gas Technology (1979). 9p. (CONF-791143—2).

From Users Association solar fuels workshop; Albuquerque, NM, USA (28 Nov 1979).

Previous investigations and experimental work performed on a cadmium-based hybrid thermoelectrochemical cycle as a means of water splitting for hydrogen production are described. It also discusses the work plan for a new effort to investigate operation of the key high-temperature endothermic step in a solar furnace-reactor. The chemistry of the cycle is: (1) $Cd(s) + 2H_2O(l) \rightarrow Cd(OH)_2 + H_2(g)$ (electrochemical step that proceeds at $V > 0.05$ volts); (2) $Cd(OH)_2(s) \rightarrow CdO(s) + H_2O(g)$ (thermochemical decomposition that proceeds at $T > 300°C$); and (3) $CdO(s) \rightarrow Cd(g) + 1/2\ O_2(g)$ (thermochemical decomposition that proceeds at $T > 1150°C$). The reaction to be further investigated through experiments in a solar furnace is step (3). Published thermodynamics data for this step are not in good agreement for the range $T > 1000°C$, and prediction of energy consumption and cycle efficiency depend on better knowledge of the operating conditions for this high-temperature step.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 9810, 10175

9861 (ALO—71) **Summary of photovoltaic application experiments designs.** Burgess, E.L.; Walker, E.A. (eds.). (Sandia Labs., Albuquerque, NM (USA); Department of Energy, Albuquerque, NM (USA). Albuquerque Operations Office). Oct 1979. 251p. Dep. NTIS, PC A12/MF A01.

Separate abstracts were prepared for the 29 papers presented. (WHK)

9862 (ALO—71, pp 3-7) **Sacramento Municipal Utilities District solar photovoltaic flat panel applications experiment.** Prideaux, D.; Spencer, R. (Acurex Corp., Mountain View, CA). Oct 1979.

In Summary of photovoltaic application experiments designs.

Acurex Corporation of Mountain View, California, has teamed with the Sacramento Municipal Utility District (SMUD) to perform a solar photovoltaic flat panel applications experiment for the Department of Energy. Acurex has completed the detailed design of a 90.8 kW peak solar energy system made up of arrays of flat plate photovoltaic collectors that track the sun. This system will supply solar-generated power to the utility power grid and will be constructed adjacent to SMUD's Rancho Seco Nuclear Powerplant. The project application, system design, and predicted performance are described. (WHK)

9863 (ALO—71, pp 8-17) **Design of a 100 kW photovoltaic flat panel system at a Washington, DC area waste treatment plant.** Belote, J.C.; Borgo, P.A.; Hamilton, M.R.; Yingst, H.A.; Young, S.K. Oct 1979.

In Summary of photovoltaic application experiments designs.

The BDM Corporation and its PRDA team have designed a 100 kilowatt flat panel photovoltaic (PV) power system to supply power to an inductive motor load for dewatering at a Washington, DC area waste treatment plant. Several key features of the proposed application and system design including the potential market and advanced technology utilized in the system are discussed. A system overview is presented that describes the wastewater treatment plant operation, the specific electrical load characteristics and the PV power system. A brief description of the conceptual system operation is presented along with a description of the major subsystems and functions of the system design. The major system elements are discussed including: (1) the PV cells and modules, (2) a power conditioning system consisting of a line-commutated, line-feeding inverter with solid state controls, (3) isolation transformers, (4) an instrumentation and control system, and (5) a power distribution system.

9864 (ALO—71, pp 18-26) **Analysis and design of a 100-kilowatt solar photovoltaic flat-panel power system for a machine and metalworking facility in Columbus, Ohio.** Noel, G.T.; Alexander, G.; Stember, L.H.; Stickford, G.H.; Broehl, J.H.; Carmichael, D.C. (Battelle Columbus Labs., OH). Oct 1979.

In Summary of photovoltaic application experiments designs.

A 100-kW-peak flat-panel photovoltaic power system to supply power to a machine-shop load in Columbus, Ohio has been designed and analyzed by a Battelle-led team. The system will provide three-phase, 240-volt a-c power to a Machining and Metalworking Facility which has 100 pieces of machinery and employs 50 machinists and other craftsmen. The system will operate in parallel with the utility which will supply backup power. Due to the close match of the array power output to the workday shop load, only a

small amount of the power generated is excess to the concurrent shop demand. When there is any excess, it will be fed to alternate loads at the site, rather than into the utility grid. The system performance analysis indicates that the system will supply approximately 115,000 kWh/year of electrical energy after all losses. The system uses high-energy-density flat-panel photovoltaic modules in a roof-mounted installation, and employs a microprocessor-controlled power conditioning unit. The overall system design, analysis of system performance and design alternatives, and detailed plans for installing, operating, and evaluating the system were developed in the project.

9865 (ALO—71, pp 27-36) **Photovoltaic roof shingle flat-panel applications experiment at Busch Gardens, Tampa, Florida.** Shepard, N.F. Jr. Oct 1979.

In Summary of photovoltaic application experiments designs.

The detailed system design for a photovoltaic roof shingle module installation at Busch Gardens, Tampa, Florida (also known as The Dark Continent) is discussed. This installation of 4312 shingle solar cell modules of a second-generation design, which was developed under this contract, produces 29.5 kW of peak output at 237 Vdc under Standard Operating Conditions (SOC) with an NOCT of 61°C. With a total gross roof area of 330.7 m^2, this installation yields an areal specific power output of 89.2 watt/m^2 at SOC. The system which uses an improved, low loss, direct-coupled, line-commutated inverter controlled to operate at the solar array maximum power operating point, delivers 208Y/120 volt, 3 phase ac in parallel with the Busch Gardens distribution network. The calculated annual ac energy output of the system is 55309 kWh with a total insolation on the roof surface of 1818.7 kWh/m^2. The resulting overall system conversion efficiency of 9.2% is considered high for a system using large area circular solar cells.

9866 (ALO—71, pp 37-41) **Photovoltaic flat panel power system for process power in battery manufacture.** Sattolo, A.J.; Truncellito, N.T.; Schanzenbach, G.P. Oct 1979.

In Summary of photovoltaic application experiments designs.

A detailed design is described for a 200 kWp solar photovoltaic power generating installation at the General Battery Company in Reading, Pennsylvania. The power generated will provide 70% of the electric energy required to operate one forming line to initially charge motorcycle batteries. Initial design criteria and constraints are established. System analyses and optimizations determine the optimum sizing of the battery storage for the load profile and year round available solar energy. The resulting modular design of ten 20 kWp modules including array, control and regulation, instrumentation, storage and installation is defined in detail and costed as a proposal to the construction and operation (Phases II & III) of this system.

9867 (ALO—71, pp 42-50) **150 kilowatt photovoltaic flat panel facility for a shopping center application, Lovington, New Mexico.** James, M.R. (Lea County Electric Cooperative, Inc., Lovington, NM). Oct 1979.

In Summary of photovoltaic application experiments designs.

The Lovington Application is located in the county seat of Lea County in Southeastern New Mexico. The facility will provide about 280 mWh annually for a shopping center. Incorporated in the concept is a utility tie which will be used to transmit the power from the photovoltaic site to the shopping center. Under normal conditions, the shopping center will consume all energy produced. During abnormal times the energy not consumed by the shopping center will be fed into utility grid. Conceptual design and systems analysis are discussed. (WHK)

9868 (ALO—71, pp 51-56) **Phase I photovoltaic flat plate application experiment on a New England telephone company switching station.** Bartoszek, J.T.; Teagan, W.P. Oct 1979.

In Summary of photovoltaic application experiments designs.

The photovoltaic panel selected for the NET Company system utilizes a 3X CPC using plastic reflectors which are protected from the environment by a tempered glass cover plate and an aluminum enclosure. The panels are approximately 3 ft by 5 ft with an active depth of 6-3/4 inches which gives the overall appearance of a flat plate photovoltaic panel. The array design utilizes 148 panels with a total active area of 2150 ft^2. This system produces about 20 kilowatts at peak power. The switching station application is particularly attractive, since it utilizes 50 volt dc power directly as it is produced by the array, so that no dc to ac inverter equipment is required. Since the output of the array never exceeds the demand of the switching station, there is no need for energy storage. The resultant photovoltaic power system is very simple and suffers none of the electrical and economic penalties associated with inverter and battery storage subsystems. In addition, this application is quite widespread, with about 500 similar buildings in the NET Company service area and an estimated 10,000 nationwide. System design and performance analysis and cost estimate, are discussed. (WHK)

9869 (ALO—71, pp 57-63) **Photovoltaic power system for the Santa Clara Community Recreation Center.** McCargo, M.; Cunnington, G.R. Jr.; Leacock, S.R.; Lott, D.R. (Lockheed Missiles & Space Company, Inc., Palo Alto, CA). Oct 1979.

In Summary of photovoltaic application experiments designs.

Detail system analyses and an optimized design were performed for a 30-kW Photovoltaic Power System (PPS) for the City of Santa Clara Community Recreation Center. A single free-standing structure housing the array and all electrical and power conditioning equipment was chosen as the optimum design. The optimization analysis included module electrical parameters, subarray panel size, spacing, shadowing effects and array orientation. Potential benefits derived from tracking and using plane reflectors were also examined, and the nontechnical issues associated with a utility-owned and -operated PPS were considered.

9870 (ALO—71, pp 64-69) **25 kW solar photovoltaic flat panel power supply for an electrodialysis water desalination unit in New Mexico.** Crutcher, J.L.; Wood, J.R. Oct 1979.

In Summary of photovoltaic application experiments designs.

Mobil Tyco Solar Energy Corporation has designed a stand-alone photovoltaic power supply to meet the requirements of an 1145 gallon/hour electrodialysis water desalination unit. The power supply consists of a 25 kW flat panel array employing silicon ribbon solar cells, a 120 kWh lead-acid battery bank, and electronics for battery charge control.

9871 (ALO—71, pp 70-79) **20 kW photovoltaic flat panel power system for an uninterruptible power supply load in El Paso, Texas.** Blevins, B.; Hsiao, R.; Masud, A.; Zwibel, H.; Brown, J.; Morrison, J.; Ponsford, F.; Golucke, L. Oct 1979.

In Summary of photovoltaic application experiments designs.

The design summary of a 20 kW photovoltaic system for an uninterruptible power supply (UPS) is presented. The UPS supplies power for assorted dc loads and the computers that control the operation of the combined cycle power plant at El Paso Electric Company's Newman Station. Two system designs are presented: one uses flat plate CdS/Cu/sub x/S modules and the other uses flat plate silicon modules.

9872 (ALO—71, pp 80-85) **Solar photovoltaic flat panel applications experiment at the Oklahoma Center for Science and Arts.** Gupta, Y.P. Oct 1979.

In Summary of photovoltaic application experiments designs.

Science Applications, Inc. has designed a photovoltaic power system for the Oklahoma Center for Science and Arts in Oklahoma City. The system has a nominal rating of 350 kW and utilizes reflector augmentation of photovoltaic modules which are arranged to maximize summer output to the summer load. The baseline system consists of 3780 photovoltaic collector modules, utilizing polycrystalline silicon cells, and companion mirror reflectors arranged in modular fashion on the roof of the Center. Total annual system output is more than 450 MWh, of which over 420 MWh is used on-site to displace about 65% of the current on-site load, or about 43% of the projected (1981) load. Another 30 MWh is returned to the utility under a buyback agreement. The total amount is approximately 850 barrels of oil, or Btu equivalent. The entire system is fully automatic, and is designed for safety and ease in maintenance, operation, and repair. It is equipped with the appropriate controls, a power monitoring system, a weather station, and other sensors for acquisition of experimental data.

9873 (ALO—71, pp 86-93) **194 kilowatt solar photovoltaic flat panel power system for the combined Beverly High School/C. H. Patten Vocational High School, Beverly, Massachusetts.** Addiss, R.R. Jr.; Lawson, P.A. Oct 1979.

In Summary of photovoltaic application experiments designs.

The 194 kW system consists of the photovoltaic array, the inverter/control subsystem, the building and utility interface, and the monitoring subsystem. The photovoltaic array consists of 56 separate subarrays of 112 photovoltaic modules each, deployed in rows on the southerly facing slope north of the school building. The wiring scheme permits individual modules to be disconnected without a radical change in subarray output current. Power is transmitted at 4160 V from the inverters and a step-up transformer to the main 4160 V utility feed line in the school. Separate metering measures power bought and sold. At the optimum tilt angle of 40°, the array provides 232 mWh of ac energy annually, or 17% of the school load. It provides a good match to the summer daily load profile, resulting primarily from the central air-conditioning. Some power is sold to the utility throughout the year, mainly on weekends. The immediate impact is an $8000 saving in the annual utility bill. Levelized busbar energy costs are reduced from $2/kWh to $1/kWh when site-specific parameters are used in the analysis instead of the JPL-specified nominal values. A fault detection and isolation scheme which can find a single module failure is incorporated into the monitoring subsystem.

9874 (ALO—71, pp 95-99) **Wilcox Memorial Hospital photovoltaic concentrator application experiment.** Lowe, W.H.H.; Masters, W.Z. (Acurex Corp., Mountain View, CA). Oct 1979.

In Summary of photovoltaic application experiments designs.

Acurex Corporation of Mountain View, California has completed the detailed design of a photovoltaic total energy system to supply both electricity and hot water heating for a hospital in the Hawiian Islands. Our system has the following features: high performance, potentially low-cost concentrators based on sealed-beam headlamp technology; high efficiency, high concentration ratio silicon cells (12% at 100 suns, 55°C/131°F); power conditioning for parallel operation with the hospital electrical utility grid; and significant economic benefits from electrical and thermal energy outputs. System design and projected performance are described. (WHK)

9875 (ALO—71, pp 101-109) **Airport Solar Photovoltaic Concentrator Project (ASPCP).** Oct 1979.

In Summary of photovoltaic application experiments designs.

Arizona Public Service Company (APS) and Motorola Incorporated Government Electronics Division (GED), during Phase I of the PRDA EG-78-D-04-0035, have accomplished the design of the 500 peak kW ASPCP power plant. The Phase I effort for the ASPCP was divided into five major tasks; System Definition, System Analysis, System Design and Component Specification, Site Layout, and Operation and Maintenance Plan Development. The work done to accomplish these tasks is summarized.

9876 (ALO—71, pp 110-119) **Commercial application of a photovoltaic concentrator system (CAPVC).** Kauffman, W.R. (BDM Corp., Albuquerque, NM). Oct 1979.

In Summary of photovoltaic application experiments designs.

The Technology Applications Center of the BDM Corporation (BDM/TAC) has completed the design of a photovoltaic concentrator applications experiment. This system denoted as CAPVC (Commercial Application of a Photovoltaic Concentrator) is a nominal 50 kW/sub p/ system designed for the roof of the new BDM/TAC headquarters in Albuquerque, New Mexico. The photovoltaic concentrating array is a single-axis linear parabolic trough with a single crystalline, silicon, photovoltaic (PV) cell. A total of 6,720 square feet of aperture will be focused on 13,944 PV cells. The photovoltaic system is designed to operate in parallel with the local utility in an augmentary load sharing mode. The array is actively cooled and the thermal energy planned for building heating during winter months.

9877 (ALO—71, pp 120-129) **Analysis and design of a 150-kilowatt solar photovoltaic concentrator power system for commercial/service buildings in single-load or load-center operations with excess power feedback into the utility grid.** Noel, G.T.; Alexander, G.; Stember, L.H.; Stickford, G.H.; Broehl, J.H.; Carmichael, D.C. (Battelle Columbus Labs., OH). Oct 1979.

In Summary of photovoltaic application experiments designs.

A 150-kW-peak concentrator-type photovoltaic power system to supply a multiple building load application in the Columbus, Ohio area was designed and analyzed by a Battelle-led team. The system will operate in parallel with the utility grid (which provides backup power) to supply either or both of two service/commercial buildings and will feed surplus power into the utility grid. The array consists of fifteen 10-kW carousel-mounted subarrays which are two-axis tracking. The subarrays each consist of 40 passively cooled concentrating modules which incorporate a primary parabolic trough reflector and a secondary compound-elliptic concentrator to achieve a geometric concentration ratio of ~ 26. The power conditioning subsystem is microprocessor controlled with maximum-power-point tracking and automatic control capabilities. The system performance analysis indicates that the system will supply approximately 147,000 kWh/year to the primary load and an additional 55,000 kWh/year to the utility grid, in the single-load operational mode. The system design and the daily and seasonal match of system output with the load are described in detail. Plans are also discussed for installation and for operational evaluations of performance, economics, and institutional issues.

9878 (ALO—71, pp 130-139) **Fresnel/photovoltaic concentrator application experiment for the Dallas-Fort Worth Airport.** O'Neill, M.J. (E-Systems, Inc., Dallas, TX). Oct 1979.

In Summary of photovoltaic application experiments designs.

An executive summary of the efforts conducted under Phase I - System Design of US Department of Energy Contract No. ET-78-C-04-5311 is given. The overall objective of the complete three-phase program is to develop and demonstrate a unique photovoltaic concentrator total energy system which, when mass-produced, will provide electrical and thermal energy at costs competitive with conventional energy sources. Toward this objective, the Phase I contract has been completed, resulting in a final system design, analytical definition of system performance and economics, and a successfully tested prototype collector. The proposed system will use 245 m^2 (aperture) of E-Systems linear Fresnel lens concentrators in combination with OCLI silicon photovoltaic cells to provide 25 kW/sub e/ (AC) and 140 kW/sub t/ to the Central Utility Facility at Dallas-Fort Worth Airport.

9879 (ALO—71, pp 150-159) **Design of a 20 kW concentrating photovoltaic/thermal system.** Liers, H.S.; McEver, W.S.; Raymond, M.G.; Close, D.R.; Harris, M.P.; Roberts, A. Oct 1979.

In Summary of photovoltaic application experiments designs.

A combined concentrating photovoltaic (PV)/thermal system has been designed by InterTechnology/Solar Corporation for use at the Fauquier High School, Warrenton, Virginia. The electrical output of the system (20 kW peak) will supply part of the lighting requirements of two large shop/classrooms in the vocational-technical area of the high school. The thermal output of the system will be used to heat a greenhouse located adjacent to the PV array. Short-term (5 to 10 minutes) electrical storage will be provided by nickel-cadmium batteries. This storage is primarily to eliminate transients due to passing clouds. Thermal storage is provided by a 6500-gallon water tank. Forty concentrating PV collectors will be used to supply the 20 kW peak electrical output. Each collector is 6' wide by 10' long and polar mounted. The collectors are of the split-parabola design to give optimal optical efficiency with a Vee shaped receiver. The receiver contains two series connected strings of 108 1" x 1" cells each. The receiver is movable along the focal line and will be seasonally adjusted to minimize end losses. The collector array consists of eight rows of five collectors. The five collectors in a row are connected in series to give nominal output voltage of 265 volts. These rows are then connected in parallel to give a nominal array current of 80 amps. Power from the array will be fed to an inverter for conversion to 277 volt, single-phase ac power from the inverter will be fed to a switching system which will feed either PV or utility power to 9 individual 2 kW lighting loads in the rooms as well as to the fan, pump, and other auxiliary loads in the control room. The switching system will be under the control of a microprocesser which provides maximum power tracking for the array.

9880 (ALO—71, pp 160-169) **64 kW concentrating photovoltaic application test center.** Jardine, D.M.; Jones, D.W. Oct 1979.

In Summary of photovoltaic application experiments designs.

Kaman Science Corporation has designed a 64 kW concentrating photovoltaics applications test center (APTEC) for the Department of Energy under Contract No. ET-78-C-04-4278. The APTEC employs ten (10) heliostats of 32X Fresnel lens spot-focusing, combined silicon cell photovoltaic/thermal arrays in a total energy system application for load sharing the electric and thermal demands of a large computer center with the interfaced utility. The combined photovoltaic power system shares basic components - a power conditioning unit, batteries and thermal conditioning equipment - with the electric and natural gas utility service, improving the computer center's operating availabiity time and displacing a portion of fossil fuel supplies required to power the computer center with solar energy.

9881 (ALO—71, pp 170-179) **Sun Valley Photovoltaic Power Project.** Goodman, F.R. Jr. (Los Angeles Dept. of Water and Power, CA). Oct 1979.

In Summary of photovoltaic application experiments designs.

An application experiment was devised for fabrication, installation, operation, and evaluation of a concentrating photovoltaic system for direct conversion of sunlight to electricity. If the experiment is performed, the photovoltaic system will be connected to an electric motor load and to an electric utility system. Provisions will be made to allow the motor load to be supplied with power from either the photovoltaic system or the utility system. When the demand of the motor load is low, the photovoltaic system will deliver excess power to the utility system for use elsewhere. Thus, the experimental installation has been designed with sufficient flexibility to enable several modes of operation to be evaluated. This type of application is a typical example of on-site power generation at an individual load center involving two-way energy exchange with the adjacent utility system. Because a growing market for photovoltaic systems in this type of application is expected in the 1980's, the experiment will provide needed information in a timely manner. The experiment was carefully planned to identify and resolve technical and institutional problems that may be encountered with this new form of supplying electricity.

9882 (ALO—71, pp 180-188) **Photovoltaic concentrator system for Roxborough Park.** Donovan, R.L.; Miller, W.D. (Martin Marietta Corp., Denver, CO). Oct 1979.

In Summary of photovoltaic application experiments designs.

The Roxborough State Park Visitor's Center, located 25 miles southwest of Denver, Colorado, is the planned site of a photovoltaic concentrator application experiment. The intent of the experiment is to demonstrate an energy independent application by combining the photovoltaic concentrator system with existing active and passive solar heating and cooling systems. The experiment represents remote installations of moderate size where the true cost of utility power is high due to transmission line construction in rough terrain. A description of the overall experiment concept is presented along

with a description of the photovoltaic concentrator system, and results of system studies.

9883 (ALO—71, pp 189-194) **Concentrating photovoltaics for the tropics.** Spotswood, B.D. (Puerto Rico Office of Energy, San Juan). Oct 1979.

In Summary of photovoltaic application experiments designs.

The Government of Puerto Rico proposes to build a concentrating photovoltaic system and install it at the Center for Energy and Environment Research (CEER) in San Juan. Under the direction of the Puerto Rico Office of Energy, the Phase I analysis and design study was completed in February 1979. Based on the results of Phase I, the proposed baseline system is a PV array with an on-site 162 kW peak electrical 1020 kW peak thermal output. The 40X collectors will be supplied by AAI Corporation, Baltimore, MD. System design and analysis are discussed.

9884 (ALO—71, pp 195-204) **Research Triangle 100 kW photovoltaic applications experiment.** Burger, R.M.; Whisnant, R.A.; Drake, W.C.; Daluge, D.R.; Alberts, R.D. Oct 1979.

In Summary of photovoltaic application experiments designs.

An experiment has been designed in which a 100 kW photovoltaic concentrator system serving the electrical load provided by an energy-efficient, office-laboratory building will be built and operated in the Research Triangle Park of North Carolina. Since the purpose of the experiment is to provide the essential data for design and installation of future operational systems, the system is designed for operational flexibility. In its main operational mode, a defined primary load is diverted from the utility during all peak-demand periods. This requires the use of 1000 kWh of lead-acid batteries for energy storage. Other operational modes provide for obtaining data on peak demand reduction, on alternative battery use strategies, and on system performance with an isolated load. Operation of the system in parallel with utility-supplied power requires that the photovoltaic array output be inverted and that the power be controlled to achieve the operational objectives. Ten 2-axis tracking arrays consisting of 70X parabolic concentrators are used. The system will provide approximately 103 megawatt-hours of power annually to the load. The design is compatible with future retrofits including more efficient solar cells, higher concentration ratios, thermal energy collection, and other technological developments, ensuring it usefulness in research and development beyond the PRDA-35 experiment.

9885 (ALO—71, pp 205-212) **Industrial Solar Breeder Project using concentrator photovoltaics. Phase I: executive summary.** Hamilton, R.; Wohlgemuth, J.; Burkholder, J.; Levine, A.; Wrigley, C.; McKegg, A.; Stori, G. Oct 1979.

In Summary of photovoltaic application experiments designs.

The Solarex Corporation has proposed to construct a 200 kW/sub e/ array as the energy source for a solar cell production line. This project will demonstrate the Solar Breeder concept, whereby a photovoltaic factory quickly becomes energy-independent, supplying its own needs and making a net energy contribution to society. A description of the system and plans is given. (WHK)

9886 (ALO—71, pp 213-221) **Photovoltaic concentrator applications experiment typical 50 kW industrial indoor lighting application.** Moeller, D.E.; Gruenwald, C.E. Oct 1979.

In Summary of photovoltaic application experiments designs.

The primary objective of Phase I of this contract was the design, necessary development and evaluations; which when implemented in hardware (Phase II) will result in a reliable, and in high volume production, a cost effective photovoltaic system for indoor lighting for an industrial application. The design requirement was to fully consider the total costs which include shipping and installation costs as well as factory cost and should be easily adaptable to various user applications. A secondary objective was the consideration of electric utility impact, financial, legal, environmental and other non-technical issues. Many of the results of this program are directly applicable to outdoor lighting applications. The resulting system is a combination of a reduction in the net energy use for the lighting load along with minimum installed solar system capacity for the substitution of solar energy for conventional utility energy. Progress is reported.

9887 (ALO—71, pp 222-230) **Trans-Pecos Photovoltaic Concentration Experiment.** Marcy, W.M.; Dudek, R.A. (Texas Tech Univ., Lubbock). Oct 1979.

In Summary of photovoltaic application experiments designs.

The Trans-Pecos Photovoltaic Concentrating Experiment is the design of a 200 kWe peak photovoltaic concentrating system applied to deep well irrigation in the Trans-Pecos region of Texas. The site selected is typical of deep well irrigation in arid regions of Texas, New Mexico, and Arizona. The existing well utilizes a 200 horse power, three phase, 480 volt induction motor to lift water 540 feet to irrigate 380 acres. The Trans-Pecos Photovoltaic Concentrating (PVC) system employs a two-axis (azimuth-elevation) tracking parabolic concentrator module that focuses sunlight at 38X concentration on two strings of actively cooled silicon solar cells. The direct current from a field of 102 collector modules is converted by a maximum power point electric power conditioning system and is connected through appropriate switchgear in parallel with the utility grid to the well's induction motor.

9888 (ALO—71, pp 231-239) **50 kWp photovoltaic concentrator application experiment using GaAs concentrator cells.** Oct 1979.

In Summary of photovoltaic application experiments designs.

The design and development of a 50 kWp concentrator GaAs solar cell system to produce peaking power to relieve the air conditioning load on the Pacific Gas and Electric Co. system during summer afternoons are discussed. Cost estimates are given. (WHK)

9889 (ALO—71, pp 240-247) **50 kW on-site concentrating solar photovoltaic power system.** Pittman, F.F. Oct 1979.

In Summary of photovoltaic application experiments designs.

Westinghouse Electric Corporation has completed the design of a 50 kWp solar photovoltaic power system sized to supply a substantial portion of the peak on-site electrical load at the Georgia Power Company Minola Road Operating Headquarters located 15 miles east of Atlanta, Georgia. The system design, completed during Phase I of the PRDA 35 program, includes manufacturing drawings of all manufactured items, specifications for all procured items, electrical interface drawings, site installation drawings, data building layouts, and instrumentation panel layouts. An evaluation of the high volume production costs of the Westinghouse system has been completed, and results show that the DOE goal of $2 per peak watt can be met.

9890 (N—79-17896) **Solar power satellite (SPS) pilot beam and communication link subsystem investigation study, phase 1. Final report.** (Raytheon Co., Wayland, MA (USA). Equipment Div.). 31 Jan 1979. Contract NAS8-33157. 85p. NTIS PC A05/MF A01.

A preliminary engineering model of ionospheric interactions with the pilot beam was established and used to demonstrate that the dual frequency baseline pilot beam system might not be viable in the presence of an unstable transmission path. Alternate approaches to remove this difficulty are described. Although ionospheric fluctuations will not significantly degrade beam pointing or raise the sidelobe levels, they will reduce transmission efficiency by upwards of 25%. Mitigating strategies to substantially reduce this effect are proposed. Based on the Klystron noise spectrum, the pilot beam transmitter power was determined as a function of frequency offset from the power beam carrier frequency. The RFI from the pilot beam, on the ground and at geosynchronous orbit is shown. Noise levels on the earth's surface due to the SPS are presented as a function of frequency and the number of SPS systems. Analysis of the communication subsystem indicates that a standard telemetry line of 1.544 MB/s would satisfy both voice and data link requirements. Additional links would be required for TV and radio transmissions.

9891 (SAND—79-7002(Vol.1)) **Design of low-cost structures for photovoltaic arrays. Volume 1 of 2: executive summary. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Nov 1979. Contract EY-76-C-04-0789. 42p. Dep. NTIS, PC A03/MF A01.

This report presents the results of an extensive study of support structures and foundations for photovoltaic solar arrays arranged in a central power plant configuration. The objectives of this work were to develop feasible low-cost structural designs to support photovoltaic solar arrays, including the provision of foundation details and cost estimates of several feasible designs. The resulting cost comparisons were used to establish the characteristics of low-cost support designs. A summary of the study approach, findings, and recommendations is presented in this volume.

9892 (SAND—79-7002(Vol.2)) **Design of low-cost structures for photovoltaic arrays. Volume 2 of 2: technical studies and appendixes. Final report.** (Bechtel National, Inc., San Francisco, CA (USA)). Nov 1979. Contract EY-76-C-04-0789. 238p. Dep. NTIS, PC A11/MF A01.

Bechtel National, Inc. has conducted a study of low-cost support structures for flat photovoltaic panels set at a fixed angle to the ground. This work began with a survey of solar system manufacturers. The results showed a diverse approach to the design of support structures and a lack of systematic design criteria. Bechtel therefore developed a series of coneptual designs of support structures and their foundations based on the use of concrete, steel or aluminum, and timber. A 6 MWe peak baseline photovoltaic power plant was conceptualized in order to bring a practical perspective to cost estimating for the designs. Detailed civil-structural design criteria were developed for this work. These criteria identified loadings for normal operating conditions and extreme environmental conditions. The study results include detailed designs for eight array support structures and foundations for flat plate arrays using 8-foot wide panels with foundations spaced 20 feet apart along the rows in the east-west direction. Other designs were produced for different

key parameters so that cost variations could be evaluated. Cost estimates for supports and foundations were shown to vary between $2 to $3 per square foot of supported panels (deflated to 1975 dollars).

9893 (SERI/TP—311-428, pp 13-15) **Photovoltaic system application experiments.** Schueler, D.G. (Sandia Lab., Albuquerque, NM). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (17 Oct 1979).

9894 (SERI/T.'—3 1-428, pp 37-57) **Battery storage for photovoltaics.** Clark, R.P. (Sandia Lab., Albuquerque, NM). 1979.

From Photovoltaic advanced R and D annual review meeting; Denver, CO, USA (1" Oct 1979).

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 9890

9895 (N—79-18460) **Austrian 10 kWe solar power plant, a project of the federal ministry for science and research.** (Bundesministerium fuer Wissenschaft und Forschung, Vienna (Austria)). 1977. 28p. NTIS PC A03/MF A01.

Concepts under development in other nations were surveyed to clarify available options in the design and construction of a small solar energy plant suitable for use in developing countries. The possibility of marketing an Austrian-made power plant capable of operating without human service was assessed as well as the possibility of supplying single components to users. Aspects of the design under consideration discussed include collector circuits, freon circuits, prime movers, generator and electric networks, plant performance, and thermal storage.

9896 (PNL-SA—6913) **Assessment of solar thermal conversion options for small power systems applications.** Apley, W.J.; Laity, W.W.; Schulte, S.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 7p. (CONF-781235—6). Dep. NTIS, PC A02/MF A01.

From Symposium on commercialization of solar and conservation technologies; Miami Beach, FL, USA (11 Dec 1978).

Under the sponsorship of the Small Power Systems Branch of the Division of Central Solar Technology, US Department of Energy, the Pacific Northwest Laboratory (PNL) is performing a project to identify, evaluate, and rank alternative solar thermal conversion concepts that have the potential for achieving commercial success as small electric power generation systems (1-10 MW/ sub e/) with initial commercialization by the mid-1980s. Discussed are the tasks established for this project and the approach adopted for performing them.

CENTRAL RECEIVER

9897 (SAN—0115/140-1) **Line-focus solar central power systems, Phase I. Topical report, September 29, 1978-April 30, 1979.** Slemmons, A.J. (SRI International, Menlo Park, CA (USA)). May 1979. Contract EY-76-C-03-0015. 115p. Dep. NTIS, PC A06/MF A01.

The subsystem and system parametric analysis for a 100 MW/ sub e/ solar central power plant of the high-temperature, line-focus, cavity-receiver type has been completed. Annual levelized busbar energy costs of 55 mills/kWh are projected for the 80th plant. The conceptual design of the plant has been initiated. A market penetration analysis and Phase II development plan will also be submitted during the next six months.

TOTAL ENERGY AND HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 9874, 9878, 9879, 9880, 9883

9898 (DOE/CS/4131—1(Vol.2), pp 231-235) **Olive Grove: a total solar energy project.** Felburg, R.A. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design philosophy of a solar total energy system for a 110-store shoppping center in Westlake Village, California, is described. The system will utilize 25,000 ft^2 of compound parabolic concentrators, a 200,000 gal water storage tank, a 320-ton absorption chiller, a 1000 ft^2 array of solar cells, and five tons of storage batteries. The system cost is approximately $1,500,000. (WHK)

OCEAN THERMAL GRADIENT POWER PLANTS

9899 (CONF-790631—16) **Multiple staging of the cold water in the open cycle OTEC systems.** Molini, A.E.; Zener, C.; Fort, T. Jr. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Chemical Engineering). 1979. Contract EG-77-S-02-4459. 4p. Dep. NTIS, PC A02/MF A01.

From 6. OTEC conference; Washington, DC, USA (19 Jun 1979).

Portions of document are illegible.

Using the cooling water of the open cycle OTEC systems in a multiple stage fashion results in its most effective utilization. Such use increases by 2-1/3 times the power production capability per unit mass of cold water, thus reducing the cost of the most expensive single item of an original installation. Later stages could utilize the effluent from previously installed stages. Also, the warmed effluent from the last stage could be utilized to enrich the nutrient value and CO_2 absorption capacity of the ocean waters near to the surface. A form of the six-tenth factor rule was used to estimate the cost of multiple stage installations using as a basis the cost of the initial unit. Results are presented relating the cost of the initial cold water supply system, number of stages, and power output per unit mass of original cold water at constant cost per unit of power.

9900 (SAN—1570-1) **Ocean Thermal Energy Conversion (OTEC) power system development: utilizing advanced high performance heat transfer techniques. Final technical progress report, August 1-December 11, 1978.** (TRW Systems and Energy, Redondo Beach, CA (USA)). 11 Dec 1978. Contract EG-77-C-03-1570. 17p. Dep. NTIS, PC A02/MF A01.

The objectives of the program are: (1) development of a preliminary design for the full-sized power system module to be used in the 100 MWe OTEC Demonstration Plant by 1984 to demonstrate operational performance and to project economic viability; (2) preliminary design for a proof-of-concept 5 MWe (nominal pilot plant, (Test Article); (3) preliminary design for proof-of-concept 1 MWe scaled heat exchangers (Test Articles); and (4) preparation of a Phase II hardware and support plan (proposal) for the scaled test articles. Status of the program is described. (WHK)

SOLAR RADIATION UTILIZATION

9901 (LBL—9630) **Solar energy program. Chapter from the Energy and Environment Division annual report, 1978.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1979. Contract W-7405-ENG-48. 42p. Dep. NTIS, PC A03/MF A01.

Work is reported on each of the following areas: (1) measurement of circumsolar radiation, (2) small particle heat exchanger, (3) passive systems analysis and design, (4) nitinol engine development, (5) radiative and passive cooling, (6) ammonia-water absorption air conditioners and heat pumps, (7) appropriate energy technology, (8) solar heating and cooling research, (9) test facility for evaluation of solar control strategies, (10) solar data network, (11) role of the proton pump... bacteriorhodopsin, (12) chemical storage of thermal energy, and (13) commercial solar demonstration program.

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 9782, 9807, 9898, 10247

9902 (AD-A—066699) **The performance of an experimental solar heating system. Interim report.** Joncich, D.M.; Leverenz, D.J.; Johnson, D.L. (Army Construction Engineering Research Lab., Champaign, IL (USA)). Feb 1979. 26p. NTIS, PC A03/MF A01.

This report describes the performance of a residential-scale, completely instrumented solar heating system located at the U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL. The investigation was made between January 1977 and April 1978. In addition, a daily profile of the performance of the system and its components is presented for a representative sunny winter day. An analysis of the solar system operation indicated that the collector array is by far the most inefficient component in the system for converting incident solar energy into useful heat. The solar system consists of 20 sq m (220 sq ft) of flat-plate, selective surface, singly glazed solar collerctors and a 7.6 cu m (2000 gal) equivalent hot water storage tank. The storage system supplies hot water for heating a 50 sq m (540 sq ft) building used by CERL as office space. There is no domestic hot water in the building. Auxiliary energy is supplied by an electric, flow-through hot water heater. The results of this research are presented in terms of mean daily averages for each month during the heating season and include instantaneous solar radiation (horizontal and in the plane of the collector), useful heat acquired by the collector, useful heat delivered to the thermal storage tank, useful heat delivered to the heating load, thermal storage heat losses, and electrical energy supplied to the pumps.

9903 (COO—2858-24(Exec.Summ.)) **Residential solar heating and cooling using evacuated tube solar collectors: CSU Solar House III. Final report, executive summary, February 1, 1976-September 30, 1978.** Ward, D.S.; Ward, J.C.; Oberoi, H.S. (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.). Mar 1979. Contract EY-76-S-02-2858. 50p. Dep. NTIS, PC A03/MF A01.

A residential solar heating and cooling system installed in Colorado State University (CSU) Solar House III is described. During the bulk of the contract (1 February 1976-31 May 1978), the CSU Solar House III system utilized the Owens-Illinois (O-I) liquid-heating evacuated tube solar collector. During the period 1 June 1978-30 September 1978, the Chamberlain liquid-heating, state-of-the-art flat-plate solar collector was evaluated for a complete cooling season. Further evaluation of the Chamberlain collector will be forthcoming, pending follow-on funding.

9904 (DOE/CS/4131—1(Vol.1)) **Final proceedings of the second solar heating and cooling commercial demonstration program contractors' review. Volume 1. Summary and analysis.** (Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center). Jul 1979. Contract EC-78-C-01-4131. 151p. (CONF-781220—(Vol.1)). Dep. NTIS, PC A08/MF A01.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The Second Solar Heating and Cooling Commercial Demonstration Program Contractors' Review was attended by over 300 representatives from demonstration projects, the Department of Energy (DOE), other Federal agencies, and Government contractors. This volume presents a thorough study of the 140 project papers printed in the three-volume proceedings. A comprehensive table describing the 140 sites is included. This table presents a description of the sites not only in terms of equipment and performance, but also those regarding their problems, successes, and other experiences. The panel discussions on demonstration projects, the National Solar Data Program and the Commercial Demonstration Program are summarized and analyzed. The results of a special survey of Commercial Demonstration Program contractors are presented. Finally, the results of a polling of Review participants on the effectiveness of the meeting are detailed. (WHK)

9905 (DOE/CS/4131—1(Vol.2)) **Final proceedings of the second solar heating and cooling commercial demonstration program contractors' review. Volume 2. Orally presented papers.** Cagle, D.B. (ed.). (Alabama Univ., Huntsville (USA). Kenneth E. Johnson Environmental and Energy Center). Jul 1979. Contract EC-78-C-01-4131. 397p. (CONF-781220—(Vol.2)). Dep. NTIS, PC A17/MF A01.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Separate abstracts were prepared for the 44 papers presented. (WHK)

9906 (DOE/CS/4131—1(Vol.2), pp 5-11) **Solar demonstration program overview.** Corcoran, W. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

DOE's responsibility for the management and coordination of federal solar programs is outlined, and the Solar Heating and Cooling Demonstration Program and Commercialization Program are briefly described. (WHK)

9907 (DOE/CS/4131—1(Vol.2), pp 13-23) **Solar energy system performance standards and criteria: NBS activities.** Dikkers, R.D. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

One of the important objectives of the National Program for Solar Heating and Cooling of Buildings is the development of "solar energy system performance standards and criteria for the production and installation of solar energy systems, subsystems, and components with appropriate provisions for consumer protection." To assist the Department of Energy (DOE) and the Department of Housing and Urban Development (HUD) in accomplishing the above objective, the National Bureau of Standards (NBS) has been actively working with standards-writing organizations, industry, designers, consumers, and other members of the building community for the past few years to help develop performance criteria and standards for solar heating and cooling applications. The current status and highlights of NBS activities which are being carried out with financial support from DOE and HUD are described.

9908 (DOE/CS/4131—1(Vol.2), pp 25-32) **Codes, standards, testing, and certification programs.** Pellish, D.M. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

DOE's role in developing a national framework for solar-related standards, codes, and testing and certification programs is discussed. Topics include testing and certification programs, the need for uniformity and coordination, a historical perspective on codes and standards, and the new approach of DOE (WHK)

9909 (DOE/CS/4131—1(Vol.2), pp 33-38) **Design and installation experiences as viewed by the HUD Residential Solar Heating and Cooling Demonstration Program.** Bloome, S. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Problems which have been encountered during HUD's residential demonstration program are discussed. The HUD grant application review process is outlined, and the design and installation problems are enumerated. (WHK)

9910 (DOE/CS/4131—1(Vol.2), pp 49-54) **Solar retrofit Executive East Office Building, Stamford, Connecticut.** Wormser, E.M. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Operational experience with the retrofitted solar-assisted heat pump for space heating the 25,000 ft^2, 2 1/2-story office building is discussed. 138 single-glazed, selectively-blackened liquid flat plate collectors augmented by hinged, anodized polished aluminum reflectors are used. A mixture of water and 50% ethylene glycol is used with a 6000 gal storage tank. The solar system will supply an estimated 55% of the present yearly heat load of 867 x 10^6 Btu/y. With only one week of preliminary data feedback from IBM, Huntsville, it appears that the system is operating about 20% better than had been predicted. The total cost of the system was $420,000. (WHK)

9911 (DOE/CS/4131—1(Vol.2), pp 55-57) **Kaw Valley solar bank, Topeka, Kansas.** Abbott, D. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design and installation of the solar water and space heating and solar absorption air conditioning system in the drive-in bank facility in Topeka, Kansas, are briefly described. The system utilized evacuated tube collectors and an 1100 gallon storage tank. The system is not yet operational. (WHK)

9912 (DOE/CS/4131—1(Vol.2), pp 59-63) **Kansas Unified School District 306, Mentor, Kansas: school heating solar demonstration project.** Hall, J.M. III. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design, operation, and performance of the solar space and water heating system at the 140,000 ft^2 school building are described. The system utilizes flat plate collectors, a water source heat pump, and 13,000 gal storage tank. Problems encountered and lessons learned are briefly discussed. (WHK)

9913 (DOE/CS/4131—1(Vol.2), pp 65-71) **Highlights Building Solar Energy Program.** Reid, E.A. Jr.; Dechow, J.P. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design and operation of the solar space and water heating system and solar absorption air conditioning system at the three-story, 25,000 ft^2 office building are described. Half-parabolic tracking solar collectors using evacuated tube receivers are used. A 5000 gal storage tank is employed. Problems encountered and lessons learned are discussed. Total construction cost was $355,200: 35% collector cost, 13% design cost, and 52% construction cost. (WHK)

9914 (DOE/CS/4131—1(Vol.2), pp 87-90) **Solar space and water heating system for a Shoney's Big Boy Restaurant in North Little Rock, Arkansas.** McAlexander, W.G.; Perry, E.H. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

A solar energy system has been designed to supply 63% of the space heating needs and 56% of the domestic hot water requirements for a 5000 ft^2 Shoney's Big Boy restaurant to be built in North Litle Rock, Arkansas. The solar heating system will employ 1428 ft^2 of flat plate hydronic collectors. The collectors shall employ double glazing and black-chrome on steel absorber plates. Because of the high demand for domestic hot water a very large fraction of the energy collected can be used. A preliminary schematic for the solar system is given. Total project cost is estimated at $82,500.

9915 (DOE/CS/4131—1(Vol.2), pp 91-101) **Application of commercial, integrated solar space heating, space cooling, and domes-**

tic hot water for the Georgia Power Company's Atlanta office building. Hensley, W.R.; Lord, L.; Jones, D.H. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design philosophy for the solar space heating, solar water heating, and solar air conditioning system for the 765,000 ft², 24-story office building is described. The system utilizes 24,760 ft² of parabolic trough collectors, 300,000 gal chilled water storage tank and 25,000 gal hot water storage tank, and a 260-ton absorption chiller. The time schedule to completion is listed. (WHK)

9916 (DOE/CS/4131—1(Vol.2), pp 103-110) **Performance of the Scattergood School solar heating system during the 1977-1978 heating season.** Heins, C. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The project was started during the summer of 1976 and completed and started up during the spring of 1977. Thus, it already has been through one entire winter. The data obtained during the 1977-1978 heating season are discussed. The heating system is a hot air system that heats the school's new 6900 ft² gymnasium and preheats water for use in the adjoining locker rooms. A collector array of 128 Solaron 2001 flat-plate collector panels is attached at an angle of 50° to the south wall of the gymnasium. The collector area is 2496 ft². An insulated, reinforced-concrete box 8 ft by 25 ft, located under the collector and containing about 65 tons of washed river gravel, provides heat storage. Above the rock storage box is a 5000 cfm air handling unit. Air is distributed to the gymnasium through overhead ductwork and a series of double deflection registers. Back-up and supplementary heat is furnished by two 250,000 Btu/h propane heaters mounted in opposite corners of the building. The collector heats water for the locker rooms by means of a heat exchanger built into the ductwork. Water is circulated through the heat exchanger and stored in two 120-gal, glass lined insulated tanks; the water serves as pre-headed water for a 52-gal, fast-recovery electrical water heater. The system was designed to provide about 75% of the space heating and about 75% of the hot water needs of the gymnasium during the heating season. The heating system is designed for 4 modes of operation. Construction cost if $93,935.

9917 (DOE/CS/4131—1(Vol.2), pp 115-118) **Two battalion headquarters and classroom facility solar project, Fort Hood, Texas.** Denys, A.D.; Armbrust, P.H. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The Two Batallion Headquarters and Classroom Facility at Fort Hood, Texas, was completed in mid-August and is now in operation. The solar system design was completed in six months and the construction was completed in 27 months. The building contains 12,300 ft² of floor area. The solar energy system, designed by General Electric using G.E. collectors, will provide approximately 90% of the total heating and cooling load. The standard sized mechanical room was expanded to provide space for the additional mechanical equipment and a visitor observation room. The system consists of a 5,635 ft² array of double-glazed flat plate solar collectors mounted above the roof on a structural grid. The collectors are tilted 20° and are facing south. The support grid on the roof is tied into the underlying steel bar joists supporting the built-up roof. The collectors have built-in headers, top and bottom, and flow through the panel is vertical from the lower header to the upper header. The built-in headers in the panels in each row are connected in parallel. The heated fluid is fed into a collector main system at the ends of each row of panels. A 15,000-gal thermal energy storage tank was buried adjacent to the building. A 100-ton Trane Company chiller is installed in the mechanical room with a 2,000-gal chiller water storage tank and a 1,000-gal expansion tank. Instrumented data are not presently available.

9918 (DOE/CS/4131—1(Vol.2), pp 119-125) **Design, construction, and performance of a retrofit solar system for Madison Hall.** Gunther, K.E. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The solar system is designed to integrate with the existing Hot Water Heating and Domestic Water Heating System. The building involved is a 7250 ft², one-story, slab on grade, frame construction with flat roof. The building provides dormitory space with 14 student rooms, house parents apartment, lounge, and necessary toilets, showers, laundry, and other support facilities. The building is insulated with 3 5/8 batts in side walls, 8" blown-in roof insulation and all glazing is thermopane. The system utilizes 2080 ft² of liquid flat plate collectors. Calculations indicate that 25% of the space heating load and 50% of the water heating load would be provided by the solar system. The design philosophy and operation of the system are discussed. Problems encountered including freeze damage are described. Construction costs are estimated at $139,290. (WHK)

9919 (DOE/CS/4131—1(Vol.2), pp 127-131) **Pandonia Elementary School solar heating and cooling project.** Wilkening, H.A. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The Padonia Elementary School is a one story masonry building of 45,000 ft² area built in 1965. It is tycical of many Maryland schools. Heating is supplied by an oil fired boiler and cooling by compression refrigeration. The solar system installed is a rooftop concentrator design developed by AAI Corporation. This concept has undergone full-scale tests on the roof of the Solar Laboratory where it has provided energy for heating and cooling this 2000 ft² building for the past two years. This concept uses the curved roof of a building as a substrate for a reflective surface, thus reducing the overall cost of the system. The system utilizes an absroption chiller of both cold storage tanks and hot water storage tanks. The solar system was designed to provide 75% of the heating and cooling for the cafetorium and the executive office suite which comprises a 10,000-ft² area of the 45,000-ft² building. The design and operation are described. System cost is approximately $660,000.

9920 (DOE/CS/4131—1(Vol.2), pp 141-149) **Northview School, Howards Grove, Wisconsin.** Linde, R. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design and construction of the solar heating system utilizing 2277 ft² of flat plate solar air heaters and a 1500 ft³, rock bin heat storage system are described. Schematics of the heating system and the flow plans are included. (WHK)

9921 (DOE/CS/4131—1(Vol.2), pp 151-158) **Solar assisted heat pump system for the Handzlik Clinic.** Zien, H.B. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design and operation of a system of solar-assisted water-to-air heat pumps for heating the two-story 8000 ft² office building are described. 756 ft² of evacuated tube collectors and a 4000 gal concrete storage tank are used. Problems and cost of the system are discussed, and lessons learned are related. (WKH)

9922 (DOE/CS/4131—1(Vol.2), pp 159-166) **Solar space heating system for West Chester Work Center.** Haron, A.S. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design, operation, and costs of the solar system for heating the one-story 9800 ft² building are described. The system utilizes 1900 ft² of selective flat plate collectors, water source heat pumps, and a 6000 gal steel storage tank. A floor plan and simplified flow diagram of the system are included. The incremental cost of the system is approximately $300,000. (WKH)

9923 (DOE/CS/4131—1(Vol.2), pp 167-174) **Esslinger Medical Building, Traverse City, Michigan.** Moutsatson, G.P. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design, costs, and problems with a solar space heating and water pre-heating system for the 2468 ft² medical building are discussed. The system utilizes a 663 ft² flat plate, double-glazed air-type collector system and a 342 ft³ pebble bed heat storage system. The heating season of 1978-1979 will determine the operational success of the system. Total building cost is $180,000 and the solar system is approximately $35,000.

9924 (DOE/CS/4131—1(Vol.2), pp 175-181) **Construction phase report: St. Charles High School solar system, St. Charles, Illinois.** Gordon, H.T. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The solar space and water pre-heating system for the 221,000 ft² school building is described. The system design incorporates 12,813 net ft² of flat plate collectors, a water source solar-assisted heat pump, and two 10,000 gal storage tanks. Construction was begun during the summer of 1978 and will be completed in late 1978 or early 1979. The overall project budget is approximately $566,000. The total bids slightly overran the budget. (WHK)

9925 (DOE/CS/4131—1(Vol.2), pp 183-187) **Carey Arboretum Solar Project update: design, submittal, construction and operational problems.** Brown, D.F. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design, bidding, and construction and design problems with the two-story 27,400 ft² building in New York are discussed. The system utilizes 5650 ft² of solar collectorss (part flat plate collector and part non-evacuated tubular semi-concentrating collectors). A solar-assisted heat pump and lined concrete storage tanks are used. (WHK)

9926 (DOE/CS/4131—1(Vol.2), pp 189-195) **New Mexico Solar Energy Institute and College of Engineering Hybrid Solar Building.** Lumsdaine, E. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The hybrid active/passive solar space heating system for the 45,000 ft² building is described. The active solar system will utilize 4400 ft² of air-type flat plate collectors and 5200 ft³ of rock storage. The storage bed will store "cool" energy during warm weather. 1400 ft² of south-facing double-glazed windows will provide the passive solar heat gain. System design and sizing are discussed. (WKH)

9927 (DOE/CS/4131—1(Vol.2), pp 197-201) **Lincoln Housing Authority Office Building solar system.** Thomsen, C.L. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The independent solar space heating system and solar water heating system for the two-story office building are described. Both systems use flat plate collectors and steel storage tanks. The design and operation are briefly discussed. The construction cost at bid was $92,450. Four change orders during construction brought the total cost to $95,997.95. (WHK)

9928 (DOE/CS/4131—1(Vol.2), pp 203-208) **Combined active and passive solar space heating and solar hot water systems for an elementary school in Boise, Idaho.** Smull, N.H.; Armstrong, G.L. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The 51,400 ft² earth-covered school building with a combined active/passive solar space heating system and a solar water heating system is described. 370 ft² of collectors supply the space heating. Construction is not yet complete. (WHK)

9929 (DOE/CS/4131—1(Vol.2), pp 209-212) **Solar heated office building for the Burns/Peters Group, Architects-Planners, Albuquerque, New Mexico.** Burns, W.L.; Bickle, L.W. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The solar water and space heating system for the two-story, 6000 ft² office building is described. 880 ft² of tracking parabolic collectors and an 1800 gal storage tank are used. The floor plan and a solar heating system schematic are included. (WHK)

9930 (DOE/CS/4131—1(Vol.2), pp 221-226) **Solar heating and cooling demonstration project.** Brock, N. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The solar space heating, water heating, and air conditioning system for the two-story 12,000 ft² chalet is described. The system consists of 1510 ft² of tracking concentrating collectors, a 5000 gal hot water storage tank, a 25-ton Arkla chiller, 600,000 Btu Raypak hydronic boiler, a 365,000 Btu domestic hot water heater, 8 water pumps, and 9 fan coil units. Problems encountered are discussed. When all the costs are in the system should cost approximately $250,000. (WHK)

9931 (DOE/CS/4131—1(Vol.2), pp 227-230) **Solar heating system for the Billings Shipping Corporation, freight distribution facility.** Baker, J. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

1890 ft² of flat plate collectors will be used to heat the 43,900 ft² freight handling facility including 4900 ft² of offices. A 2500 gallon storage tank is incorporated. The design philosophy, problems, and costs are discussed. The system is scheduled to be put in operation in mid-October 1978. (WHK)

9932 (DOE/CS/4131—1(Vol.2), pp 243-249) **Grand Junction, Colorado, DOE Solar Demonstration Project.** Price, T.D. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design and operation of the retrofitted solar space and water heating system for the 3000 ft², 120-seat cafeteria are described. The system incorporates 496 ft² of flat plate collectors and a 750 gal storage tank. The system was placed in operation on November 17, 1977. Total cost of the system was $44,663. Performance and operating experience are described. (WHK)

9933 (DOE/CS/4131—1(Vol.2), pp 253-260) **Solar system start-up and operational concerns.** Easterly, J.L. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Engineering problems that can occur during the start-up and operation of solar systems are discussed. Topics include thermal shock to the collector at start-up; piping and ducting (use of pressure release valves, pressure testing, thermal expansion joints, and leak problems); flow channeling and rock settling problems in thermal storage systems; design and optimum positioning of thermostats; heat transfer fluid problems; and freeze and boil protection. Recommendations are made regarding the design and installation phases to help avoid some problems. (WHK)

9934 (DOE/CS/4131—1(Vol.2), pp 261-269) **Solar system design and installation concerns.** Weinstein, S.D. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The physical (rather than the mechanical, electrical or structural) aspects involved in the design and installation of solar systems are articulated. The typical physical factors and problems encountered in design are addressed. In addition, the cost effectiveness of various details are considered. Design characteristics of the collector and storage loops using existing technology are discussed. The specific application of the solar energy collected (i.e. the demand loop-whether domestic hot water (DHW), heating or cooling) is not covered in this presentation. Specific experience relative to what solar designers nationwide are designing in the installation of solar collectors, array structures, piping and storage equipment are discussed with particular emphasis on cost-effective alternatives.

9935 (DOE/CS/4131—1(Vol.2), pp 289-300) **Thermal performance evaluation of the Reedy Creek Utilities solar energy system.** Wallace, C.T. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The Reedy Creek site is a two-story, 5625 ft², concrete block office building located in Lake Buena Vista, Florida. Its solar energy system is designed to provide space heating and cooling and also domestic hot water heating. A performance evaluation of the Reedy Creek Utility Solar Energy System in Lake Buena Vista, Florida for the period March through August 1978 is presented. The system is described briefly including its principal modes of operation. Unique design and installation features of interest to others considering solar energy systems are highlighted. The evaluation includes a comparison of the design performance of the system with its measured operating performance. In support of this, the long term average climatic data is compared with that taken at the site during the report period. The system provided 100% of the domestic hot water requirements and 34% of the space cooling demand during the report period. Space heating was not required.

9936 (DOE/CS/4131—1(Vol.2), pp 327-342) **Freezing problems and other reliability concerns in operational solar demonstration sites.** Wolosewicz, R.M.; Chopra, P.S. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Some of the current reliability and maintainability results and additional details on the reasons why freezing, interconnection, and control problems have occurred at the operational solar demonstration sites of the National Solar Demonstration Program are presented. The results are based on a review of 47 operating solar demonstration sites. (WHK)

9937 (DOE/CS/4131—1(Vol.2), pp 343-363) **Preliminary materials assessment in solar demonstration systems.** Cheng, C.F. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The major costs of solar energy systems are the capital investment in components and ongoing maintenance requirements. The economic consequences of material degradation and system unreliability are significant impediments to the commercial utilization of solar energy. Accordingly, the National Solar Heating and Cooling Demonstration Branch of the Department of Energy (DOE) has initiated the Solar Data Project at Argonne National Laboratory (ANL). The Project objective is to collect, evaluate, and

publish reliability, maintainability, and material performance data on solar demonstration systems. A preliminary review of the literature on critical materials in solar heating and cooling systems is presented.

9938 (DOE/CS/4131—1(Vol.2), pp 365-375) **Analysis of the construction cost of ten commercial solar energy systems.** King, T.A.; Moore, J.S.; Hale, H.J. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

As a part of the National Solar Data Program, Mueller Associates, Inc. under subcontract to the Argonne National Laboratory, has collected, analyzed, and reported construction cost data for ten operational instrumented solar energy demonstration projects. The cost data were obtained during visits to the sites, discussions with system designers, construction contractors and owners, and by review of DOE vouchers. A solar Project Cost Report has been prepared for each of the ten projects. Some of the results of analyses that were performed to determine major cost factors and their impacts on construction costs for these ten solar energy systems are described. The impacts of the following factors are among those investigated: solar system and subsytem design, physical condition of the site and building aesthetic requirements, taxes, contractual configuration, prepurchasing major equipment items, size of the project, and new vs retrofit installations. Trend data for different solar energy system type are presented along with a discussion of the reasons for the indicated cost ranges. Subsystem costs are presented as a percentage of total solar energy system cost and also in terms of dollars per square foot of collector area. The analyses discussed will be of use in developing cost estimates of solar energy systems, in performing economic analyses, and in determining the overall economic performance of similar systems.

9939 (DOE/CS/4131—1(Vol.2), pp 377-385) **Economics of solar heating: actual cost and other considerations.** Missner, S.L. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Initial operating results generated from the National Solar Heating and Cooling Demonstration Program have allowed analysis of the actual cost of solar energy generated by some of the solar sites. Four sites have already been analyzed for their first year of operation. An abbreviated version of this analysis, authored by a colleague from PRC Energy Analysis Company is presented. The analysis includes one passive heating system, one hot water system, and two space heating and hot water systems. Areas for potential cost reduction within the system are determined. Further, the analysis examines the implications of basing solar investment on life cycle cost comparisons. The search for areas of potential cost reduction is taken one step further past the actual cost analysis: it looks outside the solar systems themselves and into the policy arena. Various incentives which are directed at reducing the cost of solar energy in California are reviewed for possible application across the nation. In juxtaposition to the actual cost figures presented for four demonstration sites, these potentially cost-reducing incentives suggest a brighter future for solar acceptance than the initial cost results may indicate. A solar cost continuum is introduced which represents progress in reducing solar cost. The initial cost ratios analyzed represent the beginnng point. Solar incentives are data points along the continuum, moving toward achieving an optimal solar market - one where solar is competitive with other energy sources.

9940 (DOE/CS/30108—1) **National solar heating and cooling programs.** Blum, S.; Allen, J. (eds.). (TPI, Inc., Beltsville, MD (USA)). Aug 1979. Contract AC02-79CS30108. 58p. (CCMS—109; CONF-790541—59). Dep. NTIS, PC A04/MF A01.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

This document is a compilation of status reports on the national solar heating and cooling programs of seventeen countries participating in the Committee on the Challenges of Modern Society's Solar Energy Pilot Study. These reports were presented in two special sessions of the 25th Congress of the International Solar Energy Society held in May 1979, in Atlanta, Georgia, USA. This information exchange activity was part of the two-year follow up (1978-1980) of the Solar Energy Pilot Study, which ended in October 1978.

9941 (DOE/CS/30108—1, pp 6-9) **Belgian solar heating R and D program.** Pilatte, A. (Faculte Polytechnique de Mons, Belgium). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

In 1975, the Belgian Government announced a BFr 240 million 3-year program of research and development in energy savings. It has been a major challenge to the Belgian scientific potential to elaborate new energy options. The program aims, on the one hand, to supply, by means of technical and economical research, the necessary data to make political decisions; and on the other hand, to put the research teams necessary for further work at the disposal of government agencies. The whole program, which is coordinated by the Ministry of Scientific Research, involves about 20 research groups at universities and private and public research centers. Both solar heating and photovoltaic conversion were included and received approximately 15% of the total budget.

9942 (DOE/CS/30108—1, pp 10-14) **Canada's federal solar energy program.** Aldwinckle, R.M. (National Research Council of Canada, Ottawa, Ontario). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Begun in 1975, the Canadian solar energy program has been managed since late 1977 by the Solar Energy Project of the National Research Council of Canada. The budget has grown from $2 million in fiscal '77 to $9.5 million in the current fiscal year. The main thrust of the program is to develop solar heating technology suitable for Canadian conditions and to insure a Canadian industrial capability in the solar field. The program comprises: (a) fundamental solar studies; (b) systems trials in a wide range of conditions across Canada; (c) industrial product development; and (d) research and development in photovoltaics. Current federal incentives are directed toward providing a guaranteed market for Canadian solar products and toward strengthening the capabilities of Canadian solar manufacturers to supply these markets.

9943 (DOE/CS/30108—1, pp 15-16) **Solar energy R and D projects in Denmark.** Korsgaard, V.; Esbensen, T.V. (Technical Univ., Lyngby, Denmark). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Most of the Danish research relating to solar energy takes place at the Technical University of Denmark and the Institute of Technology in Copenhagen. The projects are financed by the Technical University, the Ministry of Commerce, and the European Community (EC). The budget for a five-year period (years not specified) includes 20 million Dcrs for solar heating R and D and 7 million Dcrs for a low-energy housing project.

9944 (DOE/CS/30108—1, pp 17-19) **French programs for research and development of solar energy for buildings.** Bellanger, M. (Commissariat a l'Energie Solaire, Paris, France); Rodot, M.; Marie, J.P. Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

This paper summarizes the current French program of solar energy R and D for heating and cooling of buildings.

9945 (DOE/CS/30108—1, pp 20-23) **Solar energy projects for heating of buildings in Germany.** Friedrich, F.J. (Projektleitung Energieforschung, Juelich, Germany). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Research and development work devoted to the utilization of solar energy constitutes an important part of the Federal Government's overall program of research and development of new energy technologies. A comprehensive description of the program can be found in the Solar Energy Technologies Programme 1977-1980. These activities are part of the Energy Research and Energy Technologies Programme 1974-1977. A brief review of the program is given here. (MOW)

9946 (DOE/CS/30108—1, pp 24) **Greek solar heating and cooling program.** Delyannis, E.; Belesiotis, R.; Delyannis, A. (Greek Atomic Energy Commission, Athens, Greece). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Solar heating and cooling activities in Greece include the following elements: a completed demonstration project at the Democritos Research Center, other planned demonstrations, participation in a joint project with the US for community planning, and some privately built solar houses.

9947 (DOE/CS/30108—1, pp 25-27) **Report on activities in Israel on solar heating and cooling of buildings.** Tabor, H. (Scientific Research Foundation, Jerusalem, Israel). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Total activity in active solar heating and cooling of buildings is relatively small, but there is much work underway on passive systems or on components that could be used in active solar heating and cooling systems. Almost all the work described below receives partial support from the Ministry of Energy and Infrastructure or, in the case of components, from the Ministry of Trade, Commerce, and Industry.

9948 (DOE/CS/30108—1, pp 30-31) **Jamaica's solar energy programs.** Ashby, W.R. (Ministry of Mining and Natural Resources, Kingston, Jamaica). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

The Scientific Research Council, which is the country's chief technical development institute, has just acquired, at the beginning of this year, an Energy Projects Division, whose creation is the result of some years of persistent effort, and similar efforts are still being made to obtain institutional support for the College of Arts, Science and Technology, abbreviated CAST, which is a technical training college also interested in alternative energy. A brief review of solar projects is given. (MOW)

9949 (DOE/CS/30108—1, pp 32-33) **Industrial solar energy activity in Monaco.** Millar, J.H. Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

FLEXTUBE S.A. of Monaco is developing solar energy components and systems for hotels, apartment buildings, hospitals, casinos, theatres, restaurants, government and office buildings, factories, gymnasiums, swimming pools, and sea-water desalination. FLEXTUBE S.A. has progressed from the use of low (1%) efficiency Alcoa flat plate collectors which warped and corroded in 1973, to east-west tracking image collectors with double wall straight-through vacuum insulated coated tubing with an efficiency of 70%.

9950 (DOE/CS/30108—1, pp 34-36) **National solar heating and cooling program in the Netherlands.** Joon, K. (Netherlands Energy Research Foundation, Petten); Sens, P.F.; van Koppen, W.J. Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

The main objective of the Dutch national program is to encourage the introduction and broadening of the applicatons of solar energy in the Netherlands at minimum costs for the community. This aim will be attained by the accumulation of knowledge and data in projects that attempt to improve the performance and reliability of solar energy systems and their components, reduce costs, and create sound industrial activity and a commercial market. A brief review of the program is given. (MOW)

9951 (DOE/CS/30108—1, pp 37-41) **National solar heating and cooling program of New Zealand.** Benseman, R.F.; Collins, M.A. (Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

9952 (DOE/CS/30108—1, pp 42-46) **Solar heating '85: Sweden's national solar heating program.** Matsson, L.O. (Tekniska Foreningen, Stockholm, Sweden). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

The new Swedish national program on solar heating is summarized. The program is an escalation of the present program. The main emphasis of the prgram is on research and development and demonstration. The research efforts will, to a great extent, be concentrated upon storage systems.

9953 (DOE/CS/30108—1, pp 47-48) **Spanish solar energy program.** Munoz-Torralbo, A. (Centro de Estudios de la Energia, Madrid, Spain). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

The challenge of limited energy resources may be met by making a serious effort in the development and generalized use of renewable energies. This paper describes the objectives, activities and programs in this field carried out by the Centro de Estudios de la Energia (Energy Research Center) of the Spanish Ministry of Energy and Industry.

9954 (DOE/CS/30108—1, pp 49-53) **United Kingdom solar heating programme.** Jefferson-Loveday, D.W. (Energy Technology Support Unit., Harwell, Oxfordshire, England). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

In June 1978 the UK Government confirmed the continuation of the Department of Energy's £ 3.6 million four-year research and development programme on solar energy which commenced early in 1977. With other money being made available, the total government expenditure on the subject will be about £ 6m over the period. It is expected that nearly two-thirds of this sum will be devoted to research and development of solar heating. A review of the program is given. (MOW)

9955 (DOE/CS/30108—1, pp 54-58) **Status of the United States' solar heating and cooling program.** Morse, F.H. (Dept. of Energy, Washington, DC). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

9956 (DSE—5093-T1) **Solar greenhouse training project. Final report.** Davis, L.; Kensil, D.; Lazar, B.; Yanda, B.; Yanda, S. (Solar Sustenance Team, Santa Fe, NM (USA)). Apr 1979. Contract EC-77-G-01-5093. 34p. Dep. NTIS, PC A03/MF A01.

The goals of this project were: (1) To train twenty teams, each from a different region, to organize and run workshops to build inexpensive, practical solar greenhouses. (2) To help create working solar greenhouse experts in the field available to respond to their community's needs. (3) To establish a national model program for solar greenhouse construction workshops. (4) To determine whether the barn-raising style used in the greenhouse construction workshops could be taught in the format of a 3 1/2 day seminar with a follow-up workshop. (5) To determine whether the audio-visual exhibit and printed materials used in the seminar were effective. (MOW)

9957 (DSE—5221-T2) **Passive solar calculation methods. Interim report.** (CCB/CUMALI Associates, Oakland, CA (USA)). 15 Apr 1979. Contract EM-78-C-01-5221. 70p. Dep. NTIS, PC A04/MF A01.

This report is the first in a series and details the results accomplished under the following tasks: (1) evaluation of existing passive solar calculation methods, (2) BLAST/DOE-1 program interface and comparison with BR-202, and (3) development of analytic relationships between the thermal balance and weighting factor techniques. The various methods available for use in thermal load analysis are presented with detailed informaton on algorithms used in the thermal balance and weighting factor techniques. (MOW)

9958 (LBL—9370) **Effect of occupant use patterns on the performance of direct-gain passive solar systems.** Kammerud, R.; Place, W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 9p. (CONF-791009—24). Dep. NTIS, PC A02/MF A01.

From International conference on energy use management; Los Angeles, CA, USA (22 Oct 1979).

The effects of thermostat control profiles on the energy consumption of the auxiliary heating system in direct-gain passive solar buildings has been studied. The building energy analysis computer program BLAST-2 was used to simulate the thermal performance of high-mass and low-mass direct gain configuration in each of two climatic regions. The results indicate that passive system performance is very sensitive to the manner in which the occupant controls the auxiliary system. Under some control strategies, the performance can actually be degraded by commonly recommended levels of thermal storage mass within the structure.

9959 (NCEI—0003) **Passive solar energy house designs for North Carolina.** (North Carolina Solar Energy Association, Research Triangle Park (USA)). Aug 1979. 18p. NTIS, PC A02/MF A01.

The house plans shown in this booklet are the award winning designs resulting from a Residential Passive Solar Energy Design Competition for North Carolina which was held between November 1, 1978 and April 9, 1979. This design competition was held by the North Carolina Solar Energy Association under contract from the North Carolina Energy Institute. It is felt that the award winning designs represent a reasonable cross-section of the current status of passive residential solar design. (MOW)

9960 (NMEI—35) **Proposal for a solar New Mexico welcome station. Final report, October 15, 1975-April 1, 1977.** Smith, P.R. (New Mexico State Univ., Las Cruces (USA). Dept. of Mechanical Engineering). Jun 1979. 163p. New Mexico State Univ., Las Cruces.

This proposal as it was finally submitted to ERDA was written by the NMSU Mechanical Engineering Department with the advice and guidance of several other groups participating in the project. It contains, as the reader will note, specifications for collectors, an energy storage system and cooling machinery. It also makes provisions for instrumentation to monitor the performance of the building and record it for use by researchers and the general public. A complete set of drawings illustrates building design plus the solar heating and cooling and instrumentation systems, and the performance estimates are documented with extensive preliminary calculations. (MOW)

9961 (PB—293069) **The new residence 1977 solar house design competition.** Eakins, G.; Banks, J. (Illinois Inst. of Natural Resources, Springfield (USA)). 1978. 59p. NTIS PC A04/MF A01.

In 1976 the Division of Energy initiated discussions on ways to stimulate professional, academic, and public interest in solar applications. In May 1976 the Illinois Committee for Energy and Architecture was formed of members representing the Illinois Division of Energy, the departments of architecture at the University of Illinois, Champaign-Urbana and Chicago Circle Campus, and the School of Architecture and Planning at the Illinois Institute of Technology, and the Illinois Council of American Institute of Architects. This committee solicited and received a grant from the U.S.

Department of Housing and Urban Development to sponsor a solar housing design competition entitled the 'New Residence: 1977'. This publication documents the 18 winning designs awarded for the 'New Residence: 1977', in the areas of single family passive design, single family active design, and multiple family active/passive design.

9962 (SOLAR/0010—79/05) **Environmental data for sites in the National Solar Data Network.** (IBM Federal Systems Div., Huntsville, AL (USA)). May 1979. Contract EG-77-C-01-4049. 266p. Dep. NTIS, PC A12/MF A01.

A major goal of the National Solar Heating and Cooling Demonstration Program is to collect and analyze data which will be used to determine the thermal performance of selected solar energy systems. To meet the goals and objectives of the Demonstration Program, the National Solar Data Network (NSDN) has been developed for the Department of Energy by the Federal Systems Division of the International Business Machines Corporation. The network consists of sensors which measure key performance parameters at a selected site, a Site Data Acquisition System (SDAS), telephone transmission circuits and a Central Data Processing System (CDPS) which collects data and performs the computations required for system performance analysis. The output of the National Solar Data Network is a monthly performance report which defines the energy contribution of the solar energy system and resultant fossil fuel savings. The performance data for homes throughout the US is included.

9963 (UCRL—83458) **Solar-assisted heat pump-swimming pool synergistics for domestic heating.** Galloway, T.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1979. Contract W-7405-ENG-48. 11p. (CONF-800101—1). Dep. NTIS, PC A02/MF A01.

From Systems simulation and economics analysis conference; San Diego, CA, USA (23 Jan 1980).

In this study for a 150m^2 home, clear performance and economic advantages are shown for a solar-assisted heat pump, providing domestic hot water and space heating and cooling, when the pump uses a year-round solar-heated swimming pool as a large thermal energy reservoir. The pool can cycle seasonably between 18 and 31°C (64 and 88°F), allowing year-round swimming, and provide an excellent water source for the heat pump and low cost, low temperature plastic solar panels operating at their near-optimum efficiency. The system has been optimized by examining the performance and cost characteristics of different glazed and unglazed solar panel collector (areas from 28 to 150m^2 and orientation from horizontal to 60° tilt) for sites in San Francisco Bay Area and in San Joaquin Valley. Actual experimental data has been used whenever possible, together with numerical simulations for performance. The optimum system was found to use 75m^2 of $44/m^2 unglazed collector at 48° tilt, a 300 GJ/year (30,000 Btu/h) capacity heat pump, and a standard size swimming pool with a solar blanket cover. Solar energy supplied about 85% of the energy requirements at $6.62/GJ ($6.62/10^{6}Btu) in July 1979 dollars. With 20 year financing (10% interest), the payout period (re-breakeven) was projected at 7 years and net savings in year 2000 at $42,701 (using the California State Tax Credit) compared against a conventional all-natural gas system. Discounting these savings back to July 1979, the present value of $6.350 would be equivalent to a 9.5% return on investment.

9964 **Apparatus and method for combined solar and heat pump heating and cooling system.** McCarson, D.M. US Patent 4,165,037. 21 Aug 1979. Filed date 21 Jun 1976. 20p.

A heating and cooling system is described which has indoor heat exchanger, an outdoor heat exchanger, a refrigerant compressor, an auxiliary heat exchanger in parallel with the outdoor heat exchanger, and a solar collector unit, with the auxiliary heat exchanger disposed within a fluid contained in a storage tank wherein the fluid is heated by circulation through the solar collector. Heat from the solar collector is utilized to heat an interior space as long as the temperature of the fluid is sufficient and thereafterwards the heat pump system is utilized for supplying heat as needed. When the efficiency of the heat pump system is substantially impaired due to low ambient conditions, the auxiliary heat exchanger is utilized to supplement heat capacity to the heat pump system.

9965 (SAN—1598-1) **Solar energy management systems development program. Final report.** (Honeywell, Inc., Minneapolis, MN (USA). Energy Resources Center). [nd]. Contract EG-77-C-03-1598. 55p. Dep. NTIS, PC A04/MF A01.

This document describes the requirements of a general-purpose solar controller, the novel control system, and sample application of that system. The investigation showed that solar systems vary in terms of temperature setpoints and differentials. Also, system design details, such as the particular placement of temperatur sensors, lengths or types of ducts, etc., affect setpoint and differential values, even for systems with similar mechanical schematics. (MOW)

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

REFER ALSO TO CITATION(S) 9807, 9977

9966 (DOE/CS/4131—1(Vol.2), pp 111-114) **Solar heated processing water for photographic laboratory.** Nitta, H. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The solar heated processing water for the photographic laboratory was designed to supply six different processing machines with hot water at varying temperatures between 80 and 120°F. These machines are used for different types of processes and are not usually run simultaneously nor continuously. Analysis showed that a system providing six gpm of 120°F and nine gal at 90°F for an eight-hour day with water supplied at 60°F would be adequate for the temperature ranges and quantities required. This represents a total energy requirement of 2.5 x 10 + 6 Btu per day or 6.25 x 10 + 8 Btu per year. The tracking parabolic trough collector array is designed to supply 80% f the annual requirement and will be installed in parrallel with the existing two gas fired boilers so that the latter can serve as the backup system when prolonged inclement weather conditions persist. The design philosophy, operation, and cost of the system are discussed. The installation is almost completed. Cost is approximately $50,536.

9967 (PB—292913) **Solar rice /dryer.** Exell, R.H.B.; Kornsakoo, S. (Asian Inst. of Tech., Bangkok (Thailand)). Oct 1978. 9p. NTIS PC A02/MF A01.

The paper briefly describes a low-cost solar heated rice dryer which is protected from the rain and can dry paddy in one or two days. Photographs and illustrations are used to help understand and implement the directions for constructing a solar rice dryer.

WATER HEATING

REFER ALSO TO CITATION(S) 9904, 9905, 9906, 9907, 9911, 9912, 9913, 9914, 9915, 9916, 9917, 9918, 9919, 9923, 9924, 9927, 9928, 9929, 9930, 9933, 9934, 9935, 9936, 9937, 9938, 9939, 9963

9968 **Crystal City passive solar hot water heater.** Contract EW-78-X-46-0249. Austin, TX; Center for Maximum Potential Building Systems ([nd]). 45p.

An inexpensive passive solar hot water heater designed to utilize parts of an existing gas hot water heater is described. The design permits year-round hot water by simple connection to a wood burning stove and other retrofit techniques. Insolation data and efficiencies of these water heaters are tabulated.

9969 (DOE/CS/4131—1(Vol.2), pp 73-77) **Solar hot water heating system: Thompson Motor Inn (Best Western) and Restaurant, Taylor, Texas.** MaCuk, B.W. Jr. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design and operation of the solar water heating system for the 40-room motel with laundry, and the 220-seating capacity restaurant are described. The systems use flat plate collectors with a 2000 gal steel tank. The system was operated for a short time but due to a disagreeable taste and odor it was shut down. The water was analyzed and it was found that the water contained 1.7 mg of phenol per liter (from the phenolic-epoxy lining of the storage tank). The system is presently shutdown awaiting the arrival of a new storage tank. (WHK)

9970 (DOE/CS/4131—1(Vol.2), pp 79-85) **Heating and cooling of a Florida office building.** Hancock, O.G. Jr. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design philosophy of the retrofitted solar heating and absorption cooling system for the 5000 ft^2 office building is described. The system utilizes 1700 ft^2 of evacuated tube collectors and separate hot water and chilled water storage tanks. Operation of the automatic control system is explained. The project is now well into the construction phase. (WHK)

9971 (DOE/CS/4131—1(Vol.2), pp 133-140) **Performance of the solar water heating systems on the Econo-Travel motor hotels.** Allred, J.W. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The initial performance data of two solar hot water heating systems now in operation and installed with a grant under DOE's hotel/motel solar demonstration program dated May 12, 1977. are given. One other system is now in operation with two others in process. System locations are Hampton, Chesapeake, Woodbridge,

Richmond, Virginia, and Bluefield, West Virginia. All hotels have two levels with flat roofs which make for ease of proper orientation of collectors to obtain maximum insolation. Additional roof reinforcements for these retrofit systems were not required. The collector supports were designed to withstand 100 miles per hour (25 psf) wind loads and a 20 psf dead load. The desired percentage of hot water heating for use in the rooms and laundry was 68%. a saving of approximately $4000 per year was calculated based on $.04 per kWh to give a 6.65 year payback time on the system which cost $24,000 to install. The annual reduction in utility cost for the system has been estimated to be much greater than the calculated savings.

9972 (DOE/CS/4131—1(Vol.2), pp 213-219) **Design considerations for a large passive water heating system in Hawaii.** Bean, M. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design which has been done on the Nuuanu YMCA solar water heating system is described. At the time this paper was written, the final design was still under consideration. The design is for a large scale thermosyphon water heating system (2422 ft^2 of collectors) on one roof, and a 727 ft^2 pumped system on an adjacent roof circulating through the same tank, using a proportional pumping system. The thermosyphon system will incorporate specular reflectors; the pumped system will be installed with horizontal collectors and a vertical diffuse white wall reflector. A 4000 gal storage tank will be used.

9973 (DOE/CS/4131—1(Vol.2), pp 237-242) **Solar heated service hot water.** Tipton, J.A. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The design of a solar water heater for a 52,000 ft^2 combination laboratory/office building in Oklahoma is described. The system utilizes 585 ft^2 of flat plate collectors and a 1200 gal storage tank. The cost of the project was $58,389.24. Non-instrumented operating experience is discussed. (WHK)

9974 (DOE/CS/4131—1(Vol.2), pp 271-278) **Thermal performance of the Hogate's Restaurant solar energy hot water system.** Aquila, V.S. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

The Hogate's Restaurant solar energy system in Washington, DC is briefly described, and a thermal performance evaluation of the system is presented. This evaluation includes comparison of predicted load and operational conditions with those measured at the site. Analytical techniques for measuring various thermal contributions are presented. Factors unique to Hogate's Restaurant which contributed to a high storage efficiency and the resulting solar contribution to the system load are discussed. Finally the savings attributed to the solar energy system when compared to a conventional system are also given.

9975 (DOE/CS/4131—1(Vol.2), pp 279-288) **Thermal performance evaluation of the ARATEX Services, Inc.** Armstrong, H.L. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

A thermal performance evaluation of the ARATEX Services, Inc. solar energy system is presented. ARATEX is an industrial laundry in Fresno, California with an average hot water demand of over 30,000 gal per day at a demand temperature of 180°F. In addition to the solar energy system, the laundry also has a heat recovery system which utilizes energy from the laundry's waste water to preheat the water entering the solar energy system. Both the heat recovery system and the solar energy system are briefly described. The thermal analysis include determination of collector efficiency, storge efficiency, and load subsystem performance. The heat recovery system reduced the hot water load at the laundry by 34%. Of the remaining load, 19% was satisfied with solar energy.

9976 (DOE/CS/4131—1(Vol.2), pp 301-307) **Comparative evaluation of the thermal performance of solar energy systems.** Bartlett, J.C. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

Comparative thermal performance evaluation of different solar energy systems is difficult due to system unique parameters and varying environmental conditions. This paper outlines a technique for comparing the thermal performance of a variety of operational solar energy systems by using a normalization procedure that reduces all systems to a common base. The examples of the parameters to be normalized are: insolation levels, loads, system size, etc. The technique is applied to comparative evaluation of three large hot water systems and results are presented based on the data collected via the National Solar Data Network during 1978.

9977 (DOE/CS/30108—1, pp 1-5) **Australian programme for solar heating and cooling.** Read, W.R.W. (Commonwealth Scientific and Industrial Research Org., Highett, Australia). Aug 1979.

From International Solar Energy Society meeting; Atlanta, GA, USA (28 May 1979).

Solar energy research, development and demonstration is continuing to expand in Australia primarily for thermal processes in domestic, commercial and industrial applications. The estimated annual expenditure is approximately $5.5 million.

9978 (DOE/TIC—10269) **Consumer awareness in solar energy.** (Hawaii State Dept. of Planning and Economic Development, Honolulu (USA)). 1978. Contract EW-78-G-49-0005. 99p. Dep. NTIS, PC A05/MF A01.

This workshop was held to provide consumers with basic technical, financial, and consumer protection information on residential solar water heaters. Nine appendices are given that relate to consumer protection.

9979 (DOE/TIC—10270) **Solar energy: an update.** (Hawaii State Dept. of Planning and Economic Development, Honolulu (USA)). 1978. 130p. Dep. NTIS, PC A07/MF A01.

A one-day workshop for professionals was held on December 1, 1977 to discuss the concerns, needs, problems and possible solutions to problems regarding solar water heating in Hawaii. The workshop included presentations by representatives of the Federal, State and County governments as well as of the solar industry. Their presentations focused on standards, codes, licensing, permits, financing, and planning for solar energy, primarily for water heating. As a result of this workshop and these Proceedings, professionals dealing with or affected by solar energy have been brought up to date on the latest Federal, State, County, and solar industry concerns, problems, and needs. It is hoped that by exchanging knowledge and discussing concerns, we can encourage accelerated transition from conventional to solar water heating systems.

9980 (LBL—9295) **Mean monthly performance of passive solar water heaters.** Place, W.; Daneshyar, M.; Kammerud, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract W-7405-ENG-48. 8p. (CONF-791022—11). Dep. NTIS, PC A02/MF A01.

From 4. national passive solar energy conference; Kansas City, KS, USA (3 Oct 1979).

A simplified analysis was used to compare the average monthly performance of a compact heater (having combined collection and storage) and a thermosiphon heater (using natural convective transfer from a collector to an insulated tank). The comparison, which was made for a range of climates and a variety of load profiles indicated that the performance of the thermosiphon is substantially superior to that of the compact heater.

9981 (N—79-18457) **Solar water heating. Final report.** Birnbreier, H.; Broschk, J.; Dietrich, B.; Gehrer, R.; Goericke, P. (Brown, Boveri und Cie A.G., Heidelberg (Germany, F.R.). Zentrales Forschungslabor). Dec 1977. 101p. NTIS PC A06/MF A01.

Tap water heating with conventional oil heating plants is performed with very low efficiency in summertime (5-20%). The object of this project was to evaluate if, in this season, solar energy can be used in middle Europe for water heating. Investigations were made on the stationary and daily efficiency of solar collectors alone as well as on complete solar systems at different places. The results show that about 50 to 90% of the heat requirement can be gained from solar energy, depending on the size of the collector area and water consumption. Due to unsteady weather conditions a supplemenatry electric heater is needed in the summer as well. The average annual useful heat gain per square meter area is about 1 kWh per day.

OTHER

9982 **Solar ice melter for use at low ambient temperatures.** Loveless, C.C. Jr. US Patent 4,162,684. 31 Jul 1979. Filed date 21 Nov 1977. 6p.

An apparatus for using solar energy to melt ice at low ambient temperatures, particularly adapted for use in livestock watering systems, is disclosed. A solar energy collector is described which gathers and transmits heat into ice which has formed in a watering receptacle at ambient air temperatures of freezing or below.

9983 **Double effect floating solar still comprising a submerged condensing system.** Eidelberg, J. US Patent 4,151,046. 24 Apr 1979. Filed date 27 Mar 1978. 2p.

A double effect floating still is described which is claimed to improve the thermal efficiency of solar stills by using the heat of

condensation for preheating the distilland before evaporating it. A corrugated metal plate is used to heat the upper layer of a body of water in order to establish a temperature difference between the upper and lower sections of the still. This temperature difference results in a vapor pressure difference, forcing the hot vapor to flow into a submerged condenser, thereby releasing its heat to the surrounding water. A typical cross section of the still in shown and discussed. (SPH)

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 9782, 9824, 9826, 9880, 9908, 9933, 9934, 9936, 9937, 9976, 10001

9984 (ALO—4299-T1) **Selective IR reflective coatings development. Semiannual report, July 24, 1978-January 24, 1979.** Lefkow, A.R. (Honeywell, Inc., Minneapolis, MN (USA). Systems and Research Center). Jan 1979. Contract EM-78-C-04-4299. 51p. Dep. NTIS, PC A04/MF A01.

Two low temperature deposition technques, a glow discharge activation technique and an ion plating technique, were investigated as methods for coating thin plastic membranes with solar transparent, infrared reflective semiconducting oxides. The glow discharge activation technique was shown to produce coatings with better optical properties than the ion plating technique. Repeatability o. coating properties with the glow discharge technique has been a problem whose solution appears to lie in better deposition process control.

9985 (ALO—5350-T1) **Survey and evaluation of current design of evacuated collectors. Technical progress report.** (Trident Engineering Associates, Inc., Annapolis, MD (USA)). 1 Mar 1979. Contract EM-78-C-04-5350. 70p. Dep. NTIS, PC A04/MF A01.

The evolution of evacuated tube collectors (ETC) is reviewed. A model flat plate collector system is described. The evacuated collectors of Owens-Illinois and General Electric are discussed. Several sites around the country that are presentely using ETC's are described. (MOW)

9986 (ALO—5359-T1) **Solar collectors. Technical progress report No. 1, September 5, 1978-March 5, 1979.** Baum, B.; Gage, M. (Springborn Labs., Inc., Enfield, CT (USA)). 27 Apr 1979. Contract EM-78-C-04-5359. 54p. Dep. NTIS, PC A04/MF A01.

A broad information search was carried out in four areas: glazings, housing materials, acrylic coatings, etching processes and AR coatings. An extensive list of all (known) US transparent polymers was developed as well as tables of plastic, ceramic and metallic materials that could conceivably function as a housing. In addition, a compilation was made of commercially available solvent and water-base acrylic coatings for use as a uv protective coating for the glazing. Eighteen transparent polymers were chosen as possible glazings and twelve materials (plastic and wood) as possible housings and exposed in the Weather-Ometer as tensile bars and for the glazings as disks for optical transmission. These same materials were also exposed on our roof to monitor soiling. A variety of solvent and water-base acrylics were selected as protective coatings and ordered. Two commercial films - Tedlar 20 and Halar 500 - with strong absorption in the uv and two commercial films containing uv absorbers - Tedlar UT and Korad 201R - were laminated by several different processes to four promising glazing materials: polyvinyl fluoride (Tedlar), polymethyl methacrylate (Plexiglass), crosslinked ethylene/vinyl acetate and thermoplastic polyester (Llumar). A variety of etching processes were briefly explored and AR coating studies started on the above four glazing films.

9987 (ALO—5367-1) **Heat conduction in partial vacuum. Technical progress report, August 7, 1978-January 31, 1979.** Thomas, J.R. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA)). Feb 1979. Contract EM-78-C-04-5367. 32p. Dep. NTIS, PC A03/MF A01.

Basic theoretical work on heat conduction in evacuated solar collectors is reported. The results include estimates for minimum partial vacuum necessary to eliminate conduction, and the effects of helium penetration into the evacuated region.

9988 **Concrete solar collectors.** Alosi, A.C. US Patent 4,164,933. 21 Aug 1979. Filed date 6 Oct 1976. 10p.

A precast solar collector panel of moldable hardenable material, such as concrete, which is of sufficient structural integrity to serve as a structural member is described. A method for forming complex passageways within a block of moldable hardenable material is discussed. The solar collector consists of a serpentine passageway in proximity to the planar surface of the panel which serves as a conduit for the heat transfer fluid. Applications of these panels in providing heat to interior building walls, swimming pools, driveways and walkways are discussed. The suitability of these panels in forming fences is considered. (SPH)

9989 (COO—2953-4) **Composition profiling of solar coating materials. Final report, April 16, 1976-April 15, 1979.** Wehner, G.K. (Minnesota Univ., Minneapolis (USA). Dept. of Electrical Engineering). Sep 1979. Contract EY-76-S-02-2953. 39p. Dep. NTIS, PC A03/MF A01.

Auger electron composition vs. depth and optical analysis revealed that a very inexpensive-to-produce [15 min. 900°C heat treatment in air] Cr_2O_3 layer on stainless steels provides an excellent diffusion barrier for preventing stainless steel constituents from entering into an IR reflective Mo coating. It was shown that with sputter deposition of Mo at high rate in a clean noble gas plasma, one can obtain Mo coatings of excellent IR reflectance [> 96% between 2.5 and 25 μm wavelength]. The optical properties [α and ϵ] of various other absorber surfaces such as stacked razor blades, cone or whisker-covered metal surfaces, plasma-sprayed chromic oxide coatings etc. were measured and explored. (MOW)

9990 (DOE/CS/4131—1(Vol.2), pp 309-326) **Comparison of actual collector array performance with predicted performance.** McCumber, W.H. Jul 1979.

From Second solar heating and cooling commercial demonstration program contractor's review; San Diego, CA, USA (13 Dec 1978).

In designing a solar energy system, the designer usually relies upon published instantaneous efficiency curves of a collector panel. However, the performance of collector arrays differs from that of a panel and under dynamic conditions the steady state panel efficiency curve does not adequately represent the collector performance. Actual dynamic performance of collector arrays in the field is compared to the performance predicted by the steady state instantaneous efficiency model of a panel. The Hottel-Whillier-Bliss model is shown to produce deviations of over 100% from hourly measured performance and 35% from monthly measured performance. The actual energy gain (Q/sub a/) is calculated from data acquired by the National Solar Data Network. Then the operating point, calculated from the same time-coherent slice of data, is projected onto the steady state collector panel efficiency curve to arrive at a predicted energy gain (Q/sub p/). The error between the steady state operation of a solar panel and a dynamic representation of system performance is a measure of the accuracy of the Hottel-Whillier-Bliss model under dynamic operating conditions for the entire solar array.

9991 (DOE/NASA/CR—161253) **Thermal performance evaluation of the Suncatcher SH-11 (Liquid) Solar Collector.** (Wyle Labs., Huntsville, AL (USA). Solar Energy Systems Div.). Jul 1979. Contract EX-76-A-29-1037. 22p. Dep. NTIS, PC A02/MF A01.

This report contains the procedures used and the results obtained during the evaluation test program on the Solar Unlimited, Inc., Suncatcher SH-11 (Liquid) Solar Collector. The flat-plate collector case assembly is made of .08 inch aluminum 3003 H14 rivited with fiberglass board insulation. The absorber consists of collared aluminum fins mechanically bonded to 3/8 inch copper tubing and coated with 3M "Nextel" black. Water is used as the working fluid. The glazing is made of a single glass, 1/8 inch water white, tempered and antireflective. The collector weight is 85 pounds with overall external dimensions of about 35.4" x 82.0" x 4.0". The test program was conducted to obtain thermal performance data on the Solar Unlimited Suncatcher SH-11 solar collector under simulated conditions. These tests were conducted using the MSFC Solar Simulator.

9992 **Solar collector.** Gross, E. (to Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,714,937/A/. 5 Oct 1978. 5p. (In German).

A conventional flat plate collector is described. The dimensions of the absorber plate are tailored to the distance between the rafters. On its back the collector carries a thermal insulation. On the side facing the sun, the collector is covered by a foil covering also the rafters and by transparent tiles.

9993 (LBL—9123) **Chemical, structural and optical characterization of a black chrome solar selective absorber.** Lampert, C.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1979. Contract W-7405-ENG-48. 173p. Dep. NTIS, PC A08/MF A01.

Thesis.

The very popular black chrome coating, Harshaw Chemical's Chromonyx was analyzed in terms of materials science to determine the nature of its microstructure and relationship to wavelength selectivity. This coating serves as an efficient solar thermal conversion coating for both concentrating and flat plate solar collectors. General properties of solar energy and selective absorbers are discussed to give a firm footing for analysis. Also, the properties and degradation modes were revealed for samples heat treated at high temperatures for short times. Several electrodeposited black chrome-substrate combinations were investigated including the favored black chrome with a dull nickel underlayer. It was found that black chrome coating thickness and surface roughness greatly influence

spectral hemispherical reflectance. To a minor extent underlayer material also altered infrared reflectance; nickel, copper and steel were evaluated. Principally, energy dispersive x-ray analysis as well as scanning and transmission electron microscopy were employed for thin film analysis. The microstructure of the as prepared and annealed coating up to 300°C consists of agglomerated 0.05 to 0.3 micron size particles with chiefly an oxide surface. Suspended within these oxide particles are 140 Å (average size) metallic chromium grains. The volume ratio of chromium to oxide increases with depth, finally forming a metal rich region at the substrate interface. Effective medium theories are discussed briefly to describe mathematically the coating's solar selectivity. Microstructural analysis was performed on 1 to 100 hour annealed specimens over the temperature range of 300 to 600°C, in atmospheres of air and medium vacuum.

9994 (N—79-18461) **Proposal for a representation of the quasisteady-state performance of flat-plate collectors.** Koch, H.; Bruck, M. (Austrian Solar and Space Agency, Vienna). Dec 1977. 17p. NTIS PC A02/MF A01.

For reasons of simplicity and clearness the calculations and reflections of this proposal are confined to flat-plate collectors with a liquid heat transfer fluid with or without glass cover. Most of the well-known proposals represent the so-called efficiency of a collector (i.e. the ratio of insulation to useful heat extracted) virtually as a function of the difference between mean collector temperature and ambient air temperature. Errors of accuracy occur with this method the higher the average collector temperature is chosen. In this proposal, low temperature collectors (i.e. collectors without thermal insulation operated in combination with heat pumps within the range of ambient air temperature) are considered. The proposal, therefore, attempts to plot the efficiency of a collector which largely avoids certain disadvantages and inaccuracies of high temperature collectors.

9995 (SERI/TR—334-244) **Basic and applied research program. Semiannual report, July-December 1978.** Butler, B.L. (ed.). (Solar Energy Research Inst., Golden, CO (USA)). Dec 1979. Contract EG-77-C-01-4042. 57p. Dep. NTIS, PC A04/MF A01.

The status of research projects in the Basic and Applied Research Program at SERI is presented for the semiannual period ending December 31, 1978. The five tasks in this program are grouped into Materials Research and Development, Materials Processing and Development, Photoconversion Research, Exploratory Research, and Energy Resource and Assessment and have been carried out by personnel in the Materials, Bio/Chemical Conversion, and Energy Resource and Assessment Branches. Subtask elements in the task areas include coatings and films, polymers, metallurgy and corrosion, optical materials, surfaces and interfaces in materials research and development; photochemistry, photoelectrochemistry, and photobiology in photoconversion; thin glass mirror development, silver degradation of mirrors, hail resistance of thin glass, thin glass manufacturing, cellular glass development, and sorption by desiccants in materials processing and development; and thermoelectric energy conversion, desiccant cooling, photothermal degradation, and amorphous materials in exploratory research. For each task or subtask element, the overview, scope, goals, approach, apparatus and equipment, and supporting subcontracts are presented, as applicable, in addition to the status of the projects in each task or subtask. Listing of publications and reports authored by personnel associated with the Basic and Applied Research Program and prepared or published during 1978 are also included.

9996 **Solar heat collector construction.** Gavin, J.G. (to Grumman Corp.). US Patent 4,164,932. 21 Aug 1979. Filed date 16 Jan 1978. 2p.

A novel and improved means for constructing solar heat collector absorber panels is described. Finplanks, which are a type of metal plate shaped to fit between two tubes in an array of evenly-space parallel tubes and which are locked to adjacent finplanks to tightly grip the tubes and hence provide a good thermal connection, comprise the means by which improved solar collector performance is achieved.

9997 **Elliptical solar reflector.** Anderson, R.V. US Patent 4,164,934. 21 Aug 1979. Filed date 16 Aug 1976. 6p.

A fixedly supported, low cost solar energy collecting device having an elliptical solar reflector is described which is capable of efficiently collecting and concentrating solar energy during all seasons and sun declinations while completely eliminating the need for mechanism for shifting the reflector to follow the sun's path. The collector includes an elongated, trough-like reflector which substantially coincides with a section of a focal end surface of an imaginary elliptical cylinder, with a heat exchange fluid tube positioned along the adjacent focal line of the imaginary elliptical cylinder. In this fashion, solar rays passing through or parallel to the remaining focal line of the imaginary cylinder and striking the reflector are focused onto the heat exchange tube, so that solar energy collection is concentrated without the necessity of precisely orienting the reflector relative to the sun. A solar energy collection device consisting of a plurality of juxtaposed reflector units is described, with the reflector focal lines being positioned along a geographic east-to-west line and at an angle of elevation equal to the latitude of the collector's position on the earth.

9998 **Luminescent solar collector structure.** Boling, N.L. (to Owens-Illinois, Inc.). US Patent 4,164,432. 14 Aug 1979. Filed date 9 Aug 1978. 8p.

A brief review is presented of recent methods for coupling of solar radiation to photocells, including concentrating lens systems and luminescent collectors. An efficient luminescent solar collector is described which is optically coupled to a small portion of an extended surface of a photovoltaic cell. The leveled edge of the collector melts the solar cell surface at an angle of 40 to 50 degrees, thus minimizing reflection losses and insuring relatively efficient coupling.

9999 **Flat plate collector.** Brunner, R. (to Deutsches Patentamt, Muenchen (Germany, F.R.)). German(FRG) Patent 2,633,977/A/. 2 Feb 1978. 24p. (In German).

A conventional solar collector is described that can be produced at low cost and has a good efficiency. Technical details are given.

HEAT STORAGE

REFER ALSO TO CITATION(S) 9952

10000 (COO—4481-1) **Rock bed storage for cooling. Final report.** Guyer, E.C.; Bourne, J.G.; Paglia, L.; Walker, D.H. (Dynatech R/D Co., Cambridge, MA (USA)). Sep 1978. Contract EG-77-C-02-4481. 188p. Dep. NTIS, PC A09/MF A01.

The technical and economic feasibility of using night-effect rock bed cooling as a means of building air conditioning has been evaluated for the various climatic regions existing in the United States. The night-effect concept has been found to be a technically viable means of achieving resonable levels of human thermal comfort in wide regions of the country. Use of a night-effect rock bed cooling system may result in excessive humidity in humid northern and northeastern regions while occasional undesirable building temperature extremes may occur in western regions because of practical control difficulties. The night-effect system is not technically feasible in the South Central and Southeast. (MOW)

10001 **Solar energy panel and medium for use therein.** Christy, D. US Patent 4,162,671. 31 Jul 1979. Filed date 15 Aug 1977. 4p.

A solar energy panel and an energy storing medium for use therewith is described. The solar energy panel comprises a container having a transparent pane and designed to hold an energy storing medium. By utilizing a transparent material the solar radiation is passed directly to the energy absorbing medium thereby increasing the operating efficiency. A novel energy storing medium is also used in the energy panel. This medium comprises a paraffinic or aromatic hydrocarbon having a specific gravity of less than one, a melting point higher than 50°F and a relatively high heat of fusion. By using an organic compound a medium is provided which has the desired energy storage capability and which is noncaustic and relatively light weight.

GEOTHERMAL ENERGY

10002 (NTIS/PS—79/0818) **Geothermal energy. Volume 3. May, 1976-July, 1978 (Citations from the Engineering Index Data Base). Report, for May 1976-July 1978.** Smith, M.F. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 329p. NTIS PC N01/MF N01.

Citations from worldwide literature on geothermal energy conversion, feasibility, development, and cost estimates are presented. Studies on geothermal exploration, drilling technology, fluid flow, convection, thermodynamics, heat extraction, and electric power plants are covered. Equipment, corrosion, reservoir engineering, and remote sensing are included. (This updated bibliography contains 323 abstracts, none of which are new entries to the previous edition.)

10003 (NTIS/PS—79/0819) **Geothermal energy. Volume 4. August 1978-July, 1979 (Citations from the Engineering Index Data Base). Report, for August 1978-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 149p. NTIS PC N01/MF N01.

Citations from worldwide literature on geothermal energy conversion, feasibility, development and cost estimates are presented. Studies on geothermal exploration, drilling technology, fluid flow, convection, thermodynamics, heat extraction, and electric

power plants are covered. Equipment, corrosion, reservoir engineering, and remote sensing are included. (This updated bibliography contains 143 abstracts, all of which are new entries to the previous edition.)

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

USA

REFER ALSO TO CITATION(S) 10010, 10012

10004 (IDO—1601-T7) **Quaternary rhyolite from the Mineral Mountains, Utah, USA. Final report, Volume 77-10.** Evans, S.H. Jr.; Nash, W.P. (Utah Univ., Salt Lake City (USA)). Mar 1978. Contract EY-76-S-07-1601. 63p. Dep. NTIS, PC A04/MF A01.

A suite of silicic volcanic rocks is associated with the Roosevelt Hot Springs geothermal area in southwestern Utah. The volcanic sequence includes Tertiary rhyolite 8 My old and obsidian, ash and rhyolite of Quaternary age. The Quaternary lavas are characterized by high silica content (76.5% SiO_2) and total alkalies in excess of 9 percent. Obsidians commonly contain greater amounts of fluorine than water. Two older flows (0.8 My) can be distinguished from younger dome and pyroclastic material (approximately 0.5 My) by subtle differences in their chemistry. The mineralogy of the rhyolites consists of alkali feldspar, plagioclase, and small amounts of Fe-Ti oxides, biotite, hornblende and rare allanite. Fe-Ti oxide temperatures are 740 to 785°C for the flows and 635 to 665°C for the domes; two feldspar temperatures give similar results. The phase relationships of bulk rock, glass and feldspar compositions demonstrate that the younger Quaternary rhyolites could have been derived from the earlier magma type, represented by the obsidian flows, by a process of crystal fractionation. The major phases which must fractionate are alkali feldspar, plagioclase and quartz with minor amounts of biotite, magnetite and ilmenite participating also. Trace element patterns support this scheme as well. The Tertiary lavas cannot be related to the Quaternary rhyolites and are thought to represent a separate event.

10005 **Forced convective heat transfer in the Monroe hot springs geothermal system.** Kilty, K.; Chapman, D.S.; Mase, C.W. (Univ. of Utah, Salt Lake City). Contract EG-78-C-07-1601. *J. Volcanol. Geotherm. Res.;* **6**: No. 3/4, 257-277(Nov 1979).

A simple, kinematic approach toward convective heat transfer is taken. Concern is not with the cause of the groundwater motion but only with the fact that the water is moving and transferring heat. The mathematical basis of convective heat transfer is the energy equation which is a statement of the first law of thermodynamics. The general solution of this equation for a specific model of groundwater flow has to be done numerically. The numerical algorithm used here employs a finite difference approximation to the energy equation that uses central differences for the heat conduction terms and one-sided differences for the heat convection terms. Gauss-Seidel iteration is then used to solve the finite difference equation at each node of a non-uniform mesh. The Monroe and Red Hill hot springs, a small hydrothermal system in central Utah, provide an example to illustrate the application of convective heat transfer theory to a geophysical problem. Two important conclusions regarding small geothermal systems follow immediately from the results of this application. First, the most rapid temperature rise in the convecting part of a geothermal system is near the surface. Below this initially rapid temperature increase the temperature increases very slowly, and thus temperatures extrapolated from shallow boreholes can be seriously in error. Second, the temperatures and heat flows observed at Monroe and Red Hill, and probably at many other small geothermal areas, can easily result from moderate vertical groundwater velocities in faults and fracture zones in an area of normal heat flow.

10006 (IDO—78-1701.b.1.1.3) **Geology of Roosevelt Hot Springs KGRA, Beaver County, Utah.** Nielson, D.L.; Sibbett, B.S.; McKinney, D.B.; Hulen, J.B.; Moore, J.N.; Samberg, S.M. (Utah Univ., Salt Lake City (USA). Research Inst.). Dec 1978. Contract EG-78-C-07-1701. 132p. Dep. NTIS, PC A07/MF A01.

The Roosevelt Hot Springs KGRA is located on the western margin on the Mineral Mountains in Beaver County, Utah. The bedrock geology of the area is presented. It is dominated by metamorphic and plutonic rocks of Precambrian age as well as felsic plutonic phases of the Tertiary Mineral Mountains Pluton. Rhyolite flows, domes, and pyroclastics reflect igneous activity between 0.8 and 0.5 million years ago. All lithologies present in the map area are described in detail with an emphasis on characteristics which will allow them to be distinguished in drill cuttings. The geothermal system at Roosevelt Hot Springs KGRA is structurally controlled with reservoir rocks demonstrating little primary permeability. North to north-northeast trending faults are the youngest structures in the area, and they control present fumarolic activity and recent hot spring activity which has deposited opaline and chalcedonic sinters. It is proposed here that the geothermal reservoirs are controlled primarily by intersections of the principal zones of faulting. Logs from Thermal Power Utah State 72-16, Getty Oil Utah State 52-21, and six shallow thermal gradient holes drilled by the University of Utah are presented in this report and have been utilized in the construction of geologic cross sections of the geothermal field.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

10007 (DGE—4014-8) **Geothermal exploration and resource assessment: R and D program benefit/cost analysis.** Dhillon, H.; El-Sawy, A.; Goldstein, S.; Meidav, T.; Pfundstein, R. (Mitre Corp., McLean, VA (USA). METREK Div.). Nov 1978. Contract EG-77-C-01-4014. 190p. (MTR—7976). Dep. NTIS, PC A09/MF A01.

The Geothermal Exploration and Resource and Reservoir Assessment (GERRA) Research and Development (R and D) Program of the Department of Energy was analyzed to evaluate its cost effectiveness and relevance to the needs of the geothermal exploration industry. This analysis was conducted in three phases. The first phase involved a review of the state-of-the-art and an identification of major R and D needs, followed by a quantitative assessment of the benefits expected from the achievement of some realistic targets for reducing the proportion of unsuccessful (non-productive) wells drilled in the course of exploration for a reservoir. In the second phase, questionnaires concerning the utility, effectiveness and need for improvement of certain commonly used exploration techniques were mailed to a set of 72 individuals active in geothermal exploration. The third phase consisted of in-person interviews with well recognized experts in geothermal exploration. The results of the quantitative analysis suggest that a benefit/cost ratio exceeding ten can be realized for the R and D expenditure by achieving a relatively modest target of improving the current weighted average exploratory drilling success ratio by 3 percentage points (i.e., from 0.24 to 0.27). The responses to the mailed questionnaires indicated that the emphasis of R and D should be on improving the data interpretation capability rather than the data collection (measurement) capability.Liquid geochemistry, seismic methods and thermal methods were identified as the techniques deserving most attention. The in-person interviews revealed that the industry is more concerned about finding buyers (utilities) for the discovered resources than about finding new resources in the near term.

10008 (NTIS/PS—79/0814) **Geothermal energy. Part 1. Exploration. Volume 3. May, 1976-June, 1979 (Citations from the NTIS data base). Report, for May 1976-June 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 264p. NTIS PC N01/MF N01.

The bibliography cites Federally-funded research on geophysical methods, such as electrical resistivity, seismology, magnetic anomaly, and electromagnetic measurements in geothermal site survey determination. Studies on well logging, remote sensing, geochemistry, mineralogy, radioactivity, mapping, volcanism, and structural geology are also cited. Criteria for location of geothermal areas are suggested in these abstracts. (This updated bibliography contains 256 abstracts, 81 of which are new entries to the previous edition.)

GEOPHYSICAL TECHNIQUES AND SURVEYS

10009 (GLR—201) **Development of downhole geothermal heat flux and thermal conductivity transducers.** Poppendiek, H.F.; Connelly, D.J.; Sellers, A.J.; Sabin, C.M.; Dunbar, J.G. (Geoscience Ltd., Solana Beach, CA (USA)). Sep 1978. Contract EG-77-C-03-1318. 71p. Dep. NTIS, PC A04/MF A01.

Two new transducers were developed which can be used in exploration holes to measure downhole geothermal heat fluxes and earth thermal conductivities. The first step in this effort consisted of analytically describing the performance characteristics of the transducers. Next, models of the transducers were built and tested in the laboratory, verifying the measurement concepts involved. Then a survey was made of possible sites where full-scale transducers could be tested in exploration holes. The two transducers were then fabricated and the test plan developed. Although some technical background material is outlined for the two transducers, the report primarily describes (1) the transducer field test effort at Middletown, (2) the downhole measurements made, and (3) the geothermal heat flux and thermal conductivity data derived from the transducer measurements. The results obtained by the two transducers are compared to each other and to other pertinent data.

10010 (IDO—78-1701.a.3) **Interpretation of a seismic refraction profile across the Roosevelt Hot Springs, Utah and vicinity.** Gertson, R.C.; Smith, R.B. (Utah Univ., Salt Lake City (USA). Dept. of

Geology and Geophysics). Mar 1979. Contract EG-78-C-07-1701. 129p. Dep. NTIS, PC A07/MF A01.

In April 1977, a seismic refraction profile was recorded across the Milford Valley, the Roosevelt Hot Springs KGRA, and the northern Mineral Mountains in southwestern Utah. Seven shot points were used to provide multiple subsurface seismic refraction coverage along the 30 km east-west profile line. Since an inspection of power spectrums revealed large components of 60 Hz noise on some traces, computer routines were used to low-pass filter all seismograms. Amplitude information was utilized by normalizing all traces that recorded the same blast. Subsurface structural modeling was conducted by means of first arrival P-wave delay-time analysis and ray tracing. Herglotz-Wiechert travel-time inversion was used for the velocity-depth distribution in the Mineral Mountains. The interpretation of the P-wave travel-times suggests that the Milford Valley fill consists of two units with a total thickness of at least 1.8 km. In the vicinity of the Roosevelt KGRA, a thin low velocity alluvial layer covers a basement igneous complex with a velocity of 5.2 km/s. Granite velocities between 3.3 km/s and 4.0 km/s were calculated from the travel-times in the Mineral Mountains.

10011 (IDO—1601-T10) **Precision leveling and gravity studies at the Roosevelt Hot Springs KGRA, Utah. Final report: Volume 77-9.** Cook, K.L.; Carter, J.A. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). Mar 1978. Contract EY-76-S-07-1601. 60p. Dep. NTIS, PC A04/MF A01.

The objective of the precision leveling and gravity surveys in the Roosevelt Hot Springs KGRA, Utah, is to provide a baseline for detecting mass reduction or movement (displacement) related to injection or withdrawal of geofluids or to changes in tectonic strain, or both of these effects. The precision leveling and gravity data obtained during the period September 1975 through October 31, 1977 are presented, and interpretations of the data are made. (MHR)

GEOCHEMICAL TECHNIQUES AND SURVEYS

10012 (EGG—2004) **Geochemical modeling of the Raft River geothermal field.** Overton, H.L.; Chaney, R.E.; McAtee, R.E.; Graham, D.L. (Idaho National Engineering Lab., Idaho Falls (USA)). Nov 1979. Contract EY-76-C-07-1570. 19p. Dep. NTIS, PC A02/MF A01.

The results to date of chemical modeling of the Raft River KGRA are presented. Earlier work indicated a northwest-southeast anomaly in the contours. Modeling techniques applied to more complete data allowed further definition of the anomaly. Models described in this report show the source of various minerals in the geothermal water. There appears to be a regional heat source that gives rise to uniform conductive heat flow in the region, but convective flow is concentrated near the upwelling in the Crook well vicinity. Recommendations are made concerning field expansion and additional work needed to refine the overall reservoir model.

10013 (IDO—78-1701.b.1.1.2) **Radon emanometry as a geothermal exploration technique; theory and an example from Roosevelt Hot Springs KGRA, Utah.** Nielson, D.L. (Utah Univ., Salt Lake City (USA). Research Inst.). Dec 1978. Contract EG-78-C-07-1701. 41p. Dep. NTIS, PC A03/MF A01.

Four radon survey lines were established over the geothermal field of Roosevelt Hot Springs KGRA. The radon flux was determined using the Westinghouse Alpha 2 system which measures the flux at each station over a period of 30 days using an alpha-sensitive dosimeter. The method was very successful in locating mapped fault systems that communicate with the structurally controlled geothermal reservoir. It is concluded that this method, coupled with a structural analysis, can be useful as a site-specific exploration tool, particularly in locating exploration holes in known geothermal areas.

EXPLORATORY DRILLING AND WELL LOGGING

REFER ALSO TO CITATION(S) 9663, 9664, 10009

10014 (DOE/ET/15391—T1) **Development of an acoustic sensor for a geothermal Borehole Televiewer.** Wonn, J.W. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Labs.). Mar 1979. Contract AC04-76ET15391. 268p. Dep. NTIS, PC A12/MF A01.

The objective of this project is to upgrade acoustic sensor technology such that appropriate well logging instruments can be made to operate under the hostile environment conditions anticipated in geothermal resource exploration and evaluation. The Borehole Televiewer (BHTV) was selected as the vehicle for this sensor improvement work, primarily because of its demonstrated ability to detect and characterize fractures under sub-geothermal conditions. The work done toward providing an improved sensor for the televiewer is described. An experimental sensor concept was devised, incorporating a thin metal acoustic window, an improved, high-temperature internal coupling fluid, and thermally resistant sensor internals. During an autoclave test, it was successfully demonstrated that the resulting experimental sensor design concept provides the basic target detection and characterization functions required of a fracture mapping, Borehole Televiewer under simulated geothermal conditions. In particular, the experimental sensor remained operational at 275°C and 7000 psi.

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

REFER ALSO TO CITATION(S) 10024, 10519, 10562

10015 (DOE/EIS—0049) **Final environmental impact statement. Geothermal demonstration program: 50 MW power plant, Baca Ranch Sandoval and Rio Arriba Counties, New Mexico.** (Department of Energy, Washington, DC (USA)). Jan 1980. 645p. Dep. NTIS, PC E08/MF E08.

The statement assesses the potential environmental impacts associated with the construction and operation of a 50 MWe geothermal power plant at the Baca Ranch Location in Redondo Canyon within the Valles Caldera in New Mexico. Impacts assessed include potential interference with Indian religious and cultural practices; conflicts with future land use plans; possible threat to the National Natural Landmark status of the Baca Ranch; potential contamination of surface water and groundwater; possible noncompliance with the State ambient air quality standard for hydrogen sulfide; the presence on the site of a State-declared endangered species; potential impacts on a Federally declared endangered species; a potential for drawdown of surface springs; potential impact on water rights; possible induced seismicity; presence of sites of archeological significance; and potential impacts of transmission corridors through the Santa Fe National Forest, the Bandelier National Monument, and private recreation lands. Additionally, the statement presents an assessment of potential long range and cumulative impacts of possible future expansion of the resource to support a 400 MWe power plant complex. A post-EIS monitoring plan to assess the effectiveness of the planned mitigation measures is also presented.

10016 (PB—292764) **Geothermal environmental impact assessment: procedures for using fauna as biological monitors of potential geothermal pollutants. Progress report for 1977.** Nelson, Z.C.; Sutton, W.W.; Mullen, A.A.; Beckert, W.F.; Potter, G.D. (Environmental Protection Agency, Las Vegas, NV (USA). Environmental Monitoring and Support Lab.). Dec 1978. 41p. NTIS PC A03/MF A01.

This is the first in a series of reports that covers the feasibility of utilizing wildlife and domestic animals to design a monitoring strategy for assessing the environmental impact of geothermal resource development. Animal tissues and animal products were collected in the vicinity of California and Utah geothermal development sites. These samples are being analyzed for selected elements so as to confirm baseline concentrations in tissues of area fauna. Small mammal populations characteristics are also being monitored at Roosevelt Hot Springs, Utah. Laboratory studies are being conducted to relate the ingestion of selected elements to subsequent changes in elemental concentration of various tissues. This report presents some preliminary data on trace element concentrations in tissues of wildlife and domestic animals. Concentrations in geothermal effluents also were determined. Quality assurance, sample collection, relative abundance of small mammals and, especially, methodology (sample preparational and analytical procedures) are discussed.

10017 (PB—293031) **An evaluation of the effects of geothermal energy development on aquatic biota in the Geysers area of California. Technical completion report.** Resh, V.H.; Flynn, T.S.; Lamberti, G.A.; McElravy, E. (California Univ., Berkeley (USA). Div. of Entomology and Parasitology (USA)). Feb 1979. 63p. NTIS PC A04/MF A01.

The Geysers of Sonoma County, California, currently the largest geothermal energy field in the world, is expected to expand its electrical generating capacity considerably in the coming years. However, these future developments may result in watershed modification and potentially deleterious effects on aquatic biota due to the topography of the area. Analysis of the response of benthic populations and communities to past and ongoing geothermal energy development and operational practices was undertaken by means of an extensive six site sampling program on Big Sulfur Creek and a concentrated colonization study above, in, and below a heavily impacted tributary (Little Geysers Creek). Differences in species diversity were noted among the six Big Sulfur Creek sites that were selected relative to the presence or absence of natural fumaroles or hot springs and the absence or stage of geothermal energy development. Distribution and colonization patterns of a population of caddisfly, Gumaga nigricula, and especially its dominance in high silt areas, suggest that both siltation and fumarole activity may select for certain populations.

10018 (UCID—18292) **Interim report: biogeochemical studies at the Geysers Geothermal Area.** Koranda, J.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Oct 1979. Contract W-7405-ENG-48. 10p. Dep. NTIS, PC A02/MF A01.

Field research at the Geysers Geothermal Area directed toward quantifying the deposition of trace elements known to be contained in the cooling tower drift is described briefly. Results from meteorological measurements, particle filtration, gas analysis of air, and a program of coordinated ecological measurements made at Unit 12 are listed. (MHR)

10019 (UCID—18488) **Assessment of the injectability of conditioned brine produced by a reaction clarification: gravity filtration system in operation at the Salton Sea geothermal field, Southern California.** Owen, L.B.; Raber, E.; Otto, C.; Netherton, R.; Neurath, R.; Allen, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Nov 1979. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

A Demonstration Reaction Clarifier - Gravity Filtration System with a 1600 GPM throughput capability was in operation at the joint DOE-SDG and E-MAGMA test facility located in the Salton Sea Geothermal Field, southern California, during the summer of 1979. The system, which was designed to condition spent effluent from a 10 MWe-size geothermal power plant, removes supersaturated dissolved species and residual suspended solids from brine prior to subsurface brine disposal via injection wells. The post-processing chemical stability of conditioned effluents was established by means of anaerobic incubation tests at 90°C. The effect of residual dissolved polymer, that might be used for the purpose of scale control in upstream power plant components on the efficiency of reaction clarification, was also evaluated. Membrane filtration and core tests were used to assess the injectability of processed brine. It was found that the clarifier-filter operational procedures and system design permitted oxygenation of the brine by air intrusion. This resulted in partial stabilization of dissolved silica and precipitation of oxides of iron. As a consequence, conditioned brine injectability was poor. However, elimination of the air intrusion problem would result in a substantial improvement in brine quality. Residual amounts of dissolved polyaminoethylene (20 ppm, by weight), a powerful antisilica precipitant, in brine was shown by means of bench-scale tests carried out at ~ 90°C to improve the efficiency of the clarification process where the additive appears to function as a flocculant.

GEOTHERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 10015, 10216

10020 (NTIS/PS—79/0816) **Geothermal energy. Part 3. Technology and general studies. Volume 3. May, 1976-December, 1977 (Citations from the NTIS data base). Report, for May 1976-December 1977.** Smith, M.F. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 247p. NTIS PC N01/MF N01.

The bibliography covers Government-sponsored research on geothermal energy conversion, power plants, heat extraction, and space heating. Studies on fluid flow, heat transfer, rock fracturing, computerized simulation, pressure, and reservoir engineering are included. Reports on economics, legislation, technology assessment, comparative evaluation with other energy sources, Government policies, and planning are also cited. (This updated bibliography contains 239 abstracts, none of which are new entries to the previous edition.)

10021 (NTIS/PS—79/0817) **Geothermal energy. Part 3. Technology and general studies. Volume 4. 1978-June, 1979 (Citations from the NTIS data base). Report, for 1978-June 1978.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 203p. NTIS PC N01/MF N01.

The bibliography covers Government-sponsored research on geothermal energy conversion, power plants, heat extraction, and space heating. Studies on fluid flow, heat transfer, rock fracturing, computerized simulation, pressure, and reservoir engineering are included. Reports on economics, legislation, technology assessment, comparative evaluation with other energy sources, Government policies, and planning are also cited. (This updated bibliography contains 195 abstracts, all of which are new entries to the previous edition.)

DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 9779

10022 (EGG-PR-G—79-017) **Performance and operability study of the Raft River 5 MW(e) pilot geothermal power plant steady-state behavior.** Bliem, C.J. (Idaho National Engineering Lab., Idaho Falls (USA)). 13 Nov 1979. Contract EY-76-C-07-1570. 40p. Dep. NTIS, PC A03/MF A01.

Estimates of the steady-state performance of the Raft River 5 MW(e) Pilot Geothermal Power Plant have been made using an existing digital computer simulation which has been updated to reflect the individual performance of the actual components in the plant. The plant output (gross and net) has been obtained as a function of geothermal fluid inlet temperature and flow rate and isobutane preheater bypass (boiler inlet subcooling). The plant performance has been determined for two ambient conditions (summer and winter extremes), and different conditions of heat exchanger fouling. These results along with transient simulations, which will be made in the near future, are needed to establish operating procedures and set point, check out control system, determine control gains, and set alarm points. Appendix A contains a brief description of the executive code (TAF), the mathmatical model of the plant, and the input-output requirements to obtain steady-state and transient solutions.

POWER PLANT SYSTEMS AND COMPONENTS

REFER ALSO TO CITATION(S) 10018, 10019

GEOTHERMAL ENGINEERING

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

10023 (NTIS/PS—79/0815) **Geothermal energy. Part 2. Corrosion and equipment. Volume 3. May, 1976-July, 1979 (Citations from the NTIS data base). Report, for May 1976-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 165p. NTIS PC N01/MF N01.

Citations of Government-sponsored research reports on corrosion and equipment studies related to geothermal energy are presented. Studies on pumps, turbines, drilling equipment, pipes, nozzles, and well casings are covered, along with studies on materials including concretes, steels, and nonferrous alloys. Silica precipitation and scale formation on equipment are also cited. Performance of equipment in working fluids and brines and the chemical processes affecting performance are included. (This updated bibliography contains 157 abstracts, 70 of which are new entries to the previous edition.)

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

REFER ALSO TO CITATION(S) 10025

10024 (PB—294136) **Geohydrological environmental effects of geothermal power production - phase IIb. Final report, 1 June 1975-30 November 1977.** Pritchett, J.W. (Systems, Science and Software, La Jolla, CA (USA)). Apr 1978. 132p. NTIS, PC A07/MF A01.

The goal of this program was to develop, validate, and apply modeling techniques for predicting the behavior of a geothermal reservoir system during fluid production and injection. Individual computer models were developed for the multi-dimensional, multiphase, time-dependent transport of fluid mass and heat in a heterogeneous reservoir and for the associated rock response. A procedure was developed to couple the rock response to the interactive fluid flow processes as well as an equation of state for flashing saline solutions. The effects of salt precipitation caused by information flashing were evaluated. The reservoir simulator was also applied to a crosssectional model of the Wairakei geothermal system to successfully reproduce the fluid production history over the interval 1953-1967; the ground surface subsidence history of the field was examined in terms of the calculated two-phase flow and the local geology. The temperature inversion often observed in geothermal fields was modeled in terms of hot fluid channeled upward through a vertical fault penetrating a horizontal aquifer. The set of governing equations was analyzed to determine the conditions under which the pressure work and/or viscous dissipation terms need to be retained in the energy balance relation. A preproduction model of a section of the Salton Sea geothermal system in the California Imperial Valley was synthesized from available data and the reservoir simulator. Predictions for the performance of the field to alternate production/injection scenarios were calculated. Coupled reservoir/subsidence calculations were performed for a synthetic reservoir system.

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

REFER ALSO TO CITATION(S) 10020, 10021

10025 (SGP-TR—35) **Stimulation and reservoir engineering of geothermal resources. Second annual report, July 1, 1978-September 30, 1979.** Kruger, P.; Ramey, H.J. Jr. (Stanford Univ., CA (USA). Stanford Geothermal Program). Sep 1979. Contract EY-76-S-03-0326-050. 112p. Dep. NTIS, PC A06/MF A01.

Individual projects are grouped under four main areas of study: energy extraction, bench-scale flow experiments, radon tracer techniques, and well test analysis. The energy extraction experiments concern the efficiency with which the in-place heat and fluids can be produced in the most economical manner. The bench-scale flow experiments cover the results of three models used to examine the properties of flow through porous media at elevated temperature and pressures. Random tracer techniques describe accelerated efforts to field test several geothermal reservoirs by both transient and transect test procedures. The well test analysis section describes several new developments: analysis of earth-tide effects, pressure transient analysis of multilayered systems, interference testing with storage and skin effects, determination of steam-water relative permeability from wellhead data, well test analysis for wells produced at constant pressure, the parallelepiped model, slug test DST analysis, and pressure transient behavior in naturally fractured reservoirs. (MHR)

DIRECT ENERGY UTILIZATION

REFER ALSO TO CITATION(S) 10020, 10021

10026 (DOE/ET/28328—T1) **Failure analysis report: geothermal heating system components, Oregon Institute of Technology, Klamath Falls, Oregon.** Mitchell, D.A. (Radian Corp., Austin, TX (USA)). 30 May 1979. Contract AC04-77ET28328. 24p. Dep. NTIS, PC A02/MF A01.

The results are presented of an examination of 17 samples obtained from various components of the subject geothermal heating system. The samples obtained for this study were selected to represent the several materials of construction and equipment ages of the various components in this system. For purposes of this report, the samples have been grouped into three categories by material: ferrous, non-ferrous and non-metallic. Failures in these components have taken the form of leakage at solder joints, tubing perforation, scaling, or valve seizure. Most components evaluated in this examination have been in service for 14 years. This work documents these failures, discusses their causes and recommends possible remedial action.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 10220

WAVE ENERGY CONVERTERS

REFER ALSO TO CITATION(S) 10220

WIND ENERGY

REFER ALSO TO CITATION(S) 9781

10027 (NTIS/PS—79/0534) **Wind power. Volume 2. 1977-April 1979 (citations from the NTIS data base). Report for 1977-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 282p. NTIS PC N01/MF N01.

The feasibility, use, and engineering aspects of wind power and windmills are discussed in these citations of Federally-funded research reports. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with comparative analyses of wind power and alternative energy sources are included, as are energy storage devices which can be used in these systems. (This updated bibliography contains 276 abstracts, 123 of which are new entries to the previous edition.)

10028 (NTIS/PS—79/0535) **Wind power. Volume 1. 1970-1977 (citations from the Engineering Index data base). Report for 1970-1977.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 225p. NTIS PC N01/MF N01.

Windmill and wind power feasibility, use, and engineering are discussed in these citations of worldwide research. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with the use of wind power in developing countries and comparative analyses of wind power and alternative energy sources are included, as are studies on energy storage systems. (This updated bibliography contains 219 abstracts, none of which are new entries to the previous edition.)

10029 (NTIS/PS—79/0536) **Wind power. Volume 2. 1978-April 1979 (citations from the Engineering Index data base). Report for 1978-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 131p. NTIS PC N01/MF N01.

Windmill and wind power feasibility, use, and engineering are discussed in these citations of worldwide research. Abstracts primarily cover the use of wind power for electric power generation and wind turbine design and performance. General studies dealing with the use of wind power in developing countries and comparative analyses of wind power and alternative energy sources are included, as are studies on energy storage systems. (This updated bibliography contains 125 abstracts, 113 of which are new entries to the previous edition.)

AVAILABILITY (CLIMATOLOGY)

10030 (PNL-SA—6918(Rev.1)) **Wind resource assessment status.** Wendell, L.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 13p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

The first objective of the WCPE's regional assessment was to develop and test prototype techniques for the analysis of wind-energy potential and distribution over a large area. These techniques involved the utilization of a much larger data set, the application of meteorological and topographic factors in the analysis, and the use of indirect methods of wind power estimation in areas where no wind measurements existed. Five states in the Pacific Northwest were selected as a test of these techniques.

10031 (RLO—2343-78/4) **Airflow over part of the Southern High Plains interpreted from LANDSAT imagery.** Carlisle, J.W.; Marrs, R.W. (Wyoming Univ., Laramie (USA). Dept. of Geology). Jul 1978. Contract EY-76-S-06-2343. 64p. Dep. NTIS, PC A04/MF A01.

An interpretation of eolian features using remote sensing techniques for part of the Southern High Plains demonstrates the use of remote sensing as an inexpensive and easily applicable tool to assess wind-energy potential. The most useful eolian features in such an interpretation are sand dunes, blowouts, dust plumes, clay dunes, playa plumes, and playa orientation. Although the relief is low to moderate in this area, topographic channeling is the most important factor in determining high wind-energy areas.

10032 (RLO—2343-79/1) **Catalog of available wind data in Idaho, Montana and Wyoming.** Marwitz, J.D.; Gilkey, K.B. (Wyoming Univ., Laramie (USA). Dept. of Atmospheric Science). Feb 1979. Contract EY-76-S-06-2343. 42p. Dep. NTIS, PC A03/MF A01.

A catalog of available wind data has been assembled for the states of Idaho, Montana and Wyoming. However, this data summary does not include those data which are in the National Climatic Center archives nor does it include those wind data collected by the US Forest Service. Since 1970, ~ 100 new surface anemometers and 12 to 15 instrumented towers have been operated for various lengths of time. Most of these data are available from areas of high wind and areas with significant numbers of eolian features. Only a minimum amount of these data has been analyzed and then only for single station climatology.

WIND ENERGY ENGINEERING

REFER ALSO TO CITATION(S) 9779

TURBINE DESIGN AND OPERATION

10033 (RFP—2992/3533/79-3) **Millville Wind Turbine Generator: failure analysis and corrective design modification.** Waldon, C.A.; Carr, M.J.; Grotzky, V.K. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). Jul 1979. Contract EY-76-C-04-3533. 25p. Dep. NTIS, PC A02/MF A01.

Fatigue cracks in the blade skins of the Millville Wind Turbine Generator were fractographically analyzed. It is believed they were caused by large flapwise deflections during a wind storm on December 4, 1978. The deflections caused the skin to buckle, which initiated rapidly growing fatigue cracks. Propagation continued to the leading edge, moving radially inward and outward along the leading edge radius. Communication between Rockwell and Millville resulted in a modified blade design which incorporates several corrective techniques.

SITE CHARACTERISTICS

10034 (PNL-SA—7603) **Siting small wind turbines.** Pennell, W.T.; Wegley, H.L. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Mar 1979. Contract EY-76-C-06-1830. 16p. Dep. NTIS, PC A02/MF A01.

A recent survey has indicated that improper siting has been a common cause of dissatisfaction among users of small wind turbines. That is, the user has not received the power output or machine life he expected. Most potential purchasers will need to be reasonably certain of the cost of wind power for their particular application before they decide to buy a wind energy conversion system (WECS). Such an assessment requires an accurate knowledge of wind characteristics at the turbine site. A procedure is presented for choosing the best available site for a wind turbine. A method for estimating the pertinent wind characteristics once the site is chosen is also described. In some cases, extensive onsite measurements may be required before an accurate analysis of turbine performance can be made.

ELECTRIC POWER ENGINEERING

REFER ALSO TO CITATION(S) 10212

10035 (DOE/EIA—0095) **Inventory of power plants in the United States: April 1979.** Shanks, K.J. (Department of Energy, Washington, DC (USA). Energy Information Administration). 25 May 1979. 384p. Dep. NTIS, PC A17/MF A01.

This inventory of power plants provides a comprehensive list of existing, standby, out of service, retired, and projected electric generating units in the United States. The data base which is the source of data for this publication is comprised of the following three files: Generating Unit Reference File (GURF); Company Information File (CIF); and Joint Ownership File (JOF). The GURF is a source of physical characteristics for all existing and currently planned generating units in the US. In addition, it contains information about units which were in the file as existing units and have since retired, and units which were scheduled to be constructed but have been cancelled from a utility's plans. The CIF, a companion file to the GURF, is a source of several descriptive characteristics of each electric utility, such as National Electric Reliability Council (NERC) region and Power Pool affiliations. The JOF, another companion file to the GURF, is a source of information on the share of ownership of a generating unit when there is multiple ownership by utilities.

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 9612

10036 (IKE-K—54-10) **Determination of the reserve capacity of a power plant park, using the example of Baden-Wuerttemberg.** Zuefle, N.; Weible, H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Kernenergetik und Energiesysteme). Jul 1979. 73p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Reserve capacity is absolutely necessary for a reliable power system. Spare capacity is required in order to compensate for intended or unintended power losses. The margin of safety and the necessary reserve capacity was determined for the power plants of the public power supply utilities in Baden-Wuerttemberg from 1960 to 1977 using an available computer program. Input data included power levels and failure-related outages of the power plants as well as the net import-rates and the maximum load. The safety margin designated could be achieved except for the years 1960 to 1963, 1965 and 1966. Since 1971 a nearly constant margin of safety of 1 was reached. It is emphasized that the dates for the net surplus of important underlay the actually used power and not the power saved by means of contracts. Further studies were performed in order to examine different methods of calculations, various configurations of power supply parks, variations of non-availabilities and the influence of the net import surplus.

WASTE-FUELED SYSTEMS

REFER ALSO TO CITATION(S) 9761, 10599, 10600

10037 (SERI/TP—33-285, pp 317-322) **Development of wood as an alternative fuel for large power generating systems.** Hamrick, J.T. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The major task was to construct a small combustion module to demonstrate burning of wood in such a manner and at such a rate as to simulate the burning of oil or natural gas in a central station boiler and to analyze the data. A small combustion module 8 ft (2.44 m) high, by 6 ft (1.83 m) wide by 10 ft (3.05 m) long was built and tested with pine and oak wood particles which had passed a half inch screen. The pine particles were pulverized from whole tree chips of Virginia pine which were purchased from a local vendor. The moisture content was 43% at time of burning. The oak particles were pulverized from chips derived from trunk and limbs only. The moisture content was 35% at the time of burning. The combustion module was preheated with propane gas until the primary combustion air reached 500°F (260°C) and the secondary air reached 1000°F (537.8°C). The wood feed was then turned on and within 15 seconds the gas was turned off. Immediately the primary air temperature began to climb and was allowed to reach 1000°F (537.8°C) while maintaining the secondary air at 1000°F (537.8°C). Complete combustion was achieved in suspension with both oak and pine. Results of an analysis of the burning in the module indicate that a 60,000 Btu/ft^3/hr heat release rate can be achieved. Burning experiments in the second phase of the program with larger wood particles and higher moisture content is continuing while a furnace is being built to burn wood at rates of 15,000 to 30,000 pounds (6,802.7 to 13,605.4 kg) per hour. The objective of the tests in the furnace is to determine scale effects. Knowledge of scale effects is necessary to design retrofit systems for central power stations that now burn oil or gas.

10038 (SERI/TP—33-285, pp 323-327) **Advanced system demonstration for the utilzation of biomass as an energy source.** Milligan, S.B.; Manar, O.J. III. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of this contract was to study the feasibility of a demonstration facility to be built by a non-government entity for the conversion of biomass to energy. It was to show that a significant portion of the present industrial need for other sources of energy could be accommodated through the use of biomass fuel and an integrated conversion facility. The facility was to demonstrate that biomass could produce steam and electricity at a competitive cost. It includes the results of several special studies which appraised factors relating to biomass availability, environmental impact, and site selection. As a result of this successful demonstration, the construction of additional biomass conversion units for commercial utilization was to be encouraged.

ECONOMICS

REFER ALSO TO CITATION(S) 10216

FUELS

REFER ALSO TO CITATION(S) 9577, 9618, 9621, 9622, 9623, 9624, 9625, 9626, 9841, 9842

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 10525, 10533, 10562, 10563, 10588, 10679

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

REFER ALSO TO CITATION(S) 9598, 9617

10039 (PB—292751) **Optical instrument for in-stack monitoring of particle size. Final report Oct 76—Oct 78.** Wertheimer, A.L.; Trainer, M.N. (Leeds and Northrup Co., North Wales, PA (USA)). Feb 1979. Contract EPA-68-02-2447. 78p. NTIS PC A05/MF A01.

A new light scattering instrument for in-situ measurements of particulates in the 0.2 to 10.0 micrometer diameter size range is described. Two modes of scattering are used, each with two wavelengths of light, to generate five size fractions by volume from a distribution of particulates. One mode measures polarized light scattered in two orthogonal orientations at an angle of 90 degrees to the optical probe beam. The second mode measures light scattered in near forward angles (4 to 11 degrees). Both modes allow the extraction of size data when particles of different sizes are present simultaneously in the sensing region. These principles have been incorporated into a prototype portable stack monitor, consisting of a 1.5 meter long, 9 cm diameter insertable probe capable of withstanding temperatures up to 260C. The optical signals are carried through fiber optic cables contained in the probe. An arc source and silicon photodetectors are outside the stack at the end of the probe, while a digital microprocessor analyzes the set of measurements and calculates the size fractions. The microprocessor, an air purge system, the

lamp power supply, and a digital printer are housed separately from the probe for ease of installation and service. The completed instrument was tested on coal-fired fly ash particulates in the laboratory at a stationary source simulator facility and in the field at a coal-fired power plant. Results and comparisons with other sizing techniques are presented.

10040 (PB—292759) **Cost analysis of lime-based flue gas desulfurization systems for new 500-MW utility boilers. Final report.** Shah, Y.M. (PEDCO-Environmental, Inc., Cincinnati, OH (USA)). Jan 1979. Contract EPA-68-02-2842. 56p. NTIS PC A04/MF A01.

Cost curves for the calculation of capital investment, operating and maintenance cost, capacity, and energy penalties are presented. These curves apply only to 500-MW coal-fired utility boilers controlled by lime based flue gas desulfurization systems. Costs can be determined for bituminous, sub-bituminous, and lignite coals with sulfur contents ranging up to about 4.5%. The cost of FGD treatment of 20 - 100 percent of the gas flow in 10 percent increments and in a broad range of sulfur removal efficiencies can also be calculated.

10041 (PB—297948) **Comparison of the availability and reliability of equipment in the electric utility industry. Final report, July 1978-March 1979.** Dickerman, J.C.; Coleman, R.T.; Burke, J.M.; Thomas, C.C. (Radian Corp., Austin, TX (USA)). May 1979. Contract EPA-68-02-2608. 229p. NTIS PC A11/MF A01.

The report gives results of a study to compare the reliability/availability of flue gas desulfurization (FGD) systems with equipment commonly used in the electric utility industry. Because many parameters used in reporting performance data for these systems have different definitions from one data reporting system to another, a direct comparison could not be made. However, a comparison model was developed--incorporating such factors as reliability, development status, and repair effort--to produce a single statistic that could be used to directly compare dissimilar pieces of equipment or systems. Study results indicate that a statistically meaningful comparison of the reliability/availability of utility FGD systems cannot now be made, primarily because of the small amount of FGD system performance data currently available. A meaningful comparison can be made only after more FGD systems are installed and more complete performance records become available.

POWER TRANSMISSION AND DISTRIBUTION

AC SYSTEMS, EHV AND UHV

10042 (SAND—79-0184) **BLID sensor evaluation at a 500-kV substation: an interim report.** (Sandia Labs., Albuquerque, NM (USA)). May 1979. Contract EY-76-C-04-0789. 20p. Dep. NTIS, PC A02/MF A01.

A joint Sandia Laboratories-Bonneville Power Administration (BPA) evaluation of a buried-line intrusion detection (BLID) sensor is being performed at a 500-kV switching substation. Measurements of the electrical environment and the effects of the environment on the sensor are described.

DC SYSTEMS

10043 (PB—297844) **Control of multiterminal dc systems.** Nozari, F. (Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering). May 1976. 127p. NTIS PC A07/MF A01.

A new control scheme for parallel multiterminal dc systems is proposed. The scheme is divided into two separate functions: (1) a supervisory control called the System Monitor-State Predictor (SMSP), which determines the steady state operating point of the system from ac voltage measurements, power requirements at the converters, and the dc network configuration; and (2) the feedback controllers which drive the system to the desired operating point supplied by the SMSP. Systematic methods are presented for computing the optimal and suboptimal feedback controllers. Specific suboptimal controllers are considered in detail and compared with the optimal control, and it is shown that use of local feedback measurements is possible with negligible loss of dynamic performance. A detailed hybrid computer simulation of the proposed EPRI-Consolidated Edison 100 MW dc line, a simplified simulation of the Pacific Northwest-Pacific Southwest dc Intertie, and finally a detailed hybrid simulation of a four terminal dc system is used to evaluate the behavior of the proposed control scheme. Results from the simulations verify the excellent performance of the control during large disturbance to the system and during steady state operation.

NUCLEAR POWER PLANTS

REFER ALSO TO CITATION(S) 10035

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 10069, 10070, 10137, 10149, 10150, 10155, 10370

10044 (CONF-791058—29) **Least squares methodology applied to LWR-PV damage dosimetry, experience and expectations.** Wagschal, J.J.; Broadhead, B.L.; Maerker, R.E. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 6p. Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The development of an advanced methodology for Light Water Reactors (LWR) Pressure Vessel (PV) damage dosimetry applications is the subject of an ongoing EPRI-sponsored research project at ORNL. This methodology includes a generalized least squares approach to a combination of data. The data include measured foil activations, evaluated cross sections and calculated fluxes. The uncertainties associated with the data as well as with the calculational methods are an essential component of this methodology. Activation measurements in two NBS benchmark neutron fields (^{252}Cf ISNF) and in a prototypic reactor field (Oak Ridge Pool Critical Assembly - PCA) are being analyzed using a generalized least squares method. The sensitivity of the results to the representation of the uncertainties (covariances) was carefully checked. Cross element covariances were found to be of utmost importance.

10045 (EGG-LOFT—5063) **LOFT test support branch data abstract report: one-sixth scale model BWR jet pump test.** Crapo, H.S. (EG and G Idaho, Inc., Idaho Falls (USA)). 29 Nov 1979. Contract EY-76-C-07-1570. 93p. (LTR—20-105). Dep. NTIS, PC A05/MF A01.

Pump performance data are presented for a 1/6 scale model jet pump in tests conducted at the LOFT Test Support Blowdown Facility. Steady-state subcooled pump characterization tests were performed over a wide range of forward and reverse flow conditions, both at room temperature, and at elevated temperature (555°K). Blowdown tests were also performed to obtain two-phase performance data in configurations simulating the flow patterns in the intact and broken loops of a BWR during a recirculation line break transient.

10046 (NUREG/CR—0797) **Post-irradiation data analysis for NRC/PNL Halden assembly IFA-431.** Nealley, C.; Lanning, D.D.; Cunningham, M.E.; Hann, C.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Oct 1979. Contract EY-76-C-06-1830. 195p. (PNL—2975). Dep. NTIS, PC A09/MF A01.

Results are presented for the post irradiation examination performed on IFA-431, which was a 6-rod test fuel assembly irradiated in Halden Reactor, Norway, under sponsorship of the Nuclear Regulatory Commission. The irradiation conditions included: peak powers of 33 kW/m; coolant pressure and temperature of 3.3 MPa and 240°C, respectively; and peak burnup of 4300 MWd/MTM. IFA-431 included instrumented rods of basic boiling water reactor design, with variations in fill gas composition, gap size, and UO_2 fuel type. The irradiation was designed to measure the effect of these variations upon fuel rod thermal and mechanical performance. The post irradiation examination assessed the permanent changes to the rods, including induced radioactivity, cladding deformation, fission gas release, and fuel densification.

10047 (NUREG/CR—0994) **Radiative heat transfer model for the TRAC code.** Mandell, D.A. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 86p. (LA—7965-MS). Dep. NTIS, PC A05/MF A01.

A radiative heat transfer model proposed for the boiling water reactor (BWR) version of the Transient Reactor Analysis Code (TRAC) is described. The model includes radiative heat transfer to the nonequilibrium two-phase fluid, as well as surface-to-surface radiative heat transfer. Radiative properties and geometric view factors are calculated. It is assumed that each surface is a gray surface and that the liquid and vapor are gray fluids. A stand-alone code RADHT is described, and this code was used to examine the effect of the void fraction, liquid droplet diameter, vapor temperature, wall emissivity, and the number of rod groups. The results show that five rod groups (including the channel wall) are sufficient to describe the radiative heat transfer in a BWR bundle. The results also show that radiative heat transfer to the two-phase mixture should be considered in addition to surface-to-surface effects.

10048 (PNL-SA—7381) **Impact of LWR decontamination on radwaste systems.** Perrigo, L.D.; Divine, J.R. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1979. Contract EY-76-C-06-1830. 13p. (CONF-790313—5). Dep. NTIS, PC A02/MF A01.

From NACE/Corrosion 1979 meeting; Atlanta, GA, USA (12 Mar 1979).

Increased radiation levels around certain reactors in the United States and accompanying increases in personnel exposures are causing a reexamination of options available to utilities to continue operation. One of the options is decontamination of the primary system to reduce radiation levels. The Battelle-Northwest study of decontamination and its impact on radwaste systems has been directed towards existing reactors and allied systems as they are employed during their operational lifetimes. Decommissioning and cleanup during such work are not within the scope of this project although certain processes and waste systems might be similar. Rupture debris cleanup represents a special situation that requires different design features and concepts and it is not a part of this study.

10049 (UCID—18145) **Status of evaluations and modifications of diesel generator status annunciator systems at various US nuclear power plants.** Shindell, B.M.; Rumble, R.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.; EG and G, Inc., San Ramon, CA (USA). Energy Measurements Group). Oct 1979. Contract W-7405-ENG-48. 59p. Dep. NTIS, PC A04/MF A01.

This report documents the current status of evaluations and modifications to the diesel generator status annunciators in a number of US nuclear power plants. These modifications may be required in order to: ensure that all conditions which might render the diesel generators incapable of automatic starting are annunciated in the control room; ensure that the wording on the control room annunciator clearly indicates to the operator that the diesel generator is unavailable if such is the case; and separate disabling and non-disabling annunciation.

10050 **Operating US power reactors.** Cottrell, W.B. (Oak Ridge National Lab., TN). *Nucl. Saf.;* **20**: No. 4, 493-499(Jul 1979).

The operation of US power reactors during March and April 1979 is summarized. Events of special note are discussed, and the operational performance of all licensed power reactors is presented.

10051 **Seismic response analysis of nuclear reactor buildings under consideration of soil-structure interaction with torsional behaviour.** Mizuno, N.; Iida, T. (Chubu Electric Power Co. Inc., Nagoya (Japan)); Tsushima, Y.; Araki, T.; Nojima, O. (Takenaka Komuten Co. Ltd., Tokyo (Japan). Technical Research Lab.). pp K2/16 1-14 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This paper is the further report of the previous SMIRT-3 Paper K3/2 in which an approximate explanation is presented in regard to the experimental and analytical studies of No. 1 reactor building (BWR) of Hamaoka Nuclear Power Station. In this paper, the seismic response analysis is described in detail for estimating the soil-structure interaction effects with the torsional behaviour. Through these studies, it is concluded that the radiation damping effects are remarkable in the reactor building and the proposed seismic response analysis is reasonable for estimating the soil-structure interaction with the torsional behaviour of structure.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 10044, 10048, 10049, 10050, 10069, 10070, 10136, 10146, 10149, 10155, 10156, 10163, 10167

10052 (IEA-DT—091) **Integrity evaluation of the pressure vessels of Angra-2 and Angra-3 reactors by stress analysis.** Gomes, E. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov 1978. 92p. (In Portuguese). Dep. NTIS (US Sales Only), PC A06/MF A01.

The integrity of the reactor pressure vessel of the unit II/III of the Nuclear Power Station at 'Angras do Reis' is evaluated by stress analysis, through the dynamics relaxation method. For the solution of the problem an axisymmetric model is fixed. Initially, the data of the Oak Ridge Vessel V-7 is compared with those obtained by two computer programs used in this study. The methods used in the computer programs are FEM and DEM. All the results are compared with the ASME Code Section III 1974 edition. The range deviation is determined to 99% confidence limit, in order to minimize the error probabilities. Finally, the equivalent intensity stress obtained is calculated and compared with the acceptable values of the ASME Code Section III, 1974 edition.

10053 (UCID—18138) **Technical evaluation of the alternate to the keylock control to the bypass valves for the Davis-Besse nuclear power plant, Unit 1.** Ibarra, J.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1979. Contract W-7405-ENG-48. 13p. Dep. NTIS, PC A02/MF A01.

This report documents the technical evaluation of the alternate to the keylock control to the bypass valves for the Davis-Besse nuclear power plant, Unit 1. The review criteria are inferred from the NRC Reactor Safety Study (WASH-1400) and the Safety Evaluation Report for Davis-Besse. This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues Program being conducted for the US Nuclear Regulatory Commission by Lawrence Livermore Laboratory.

10054 (UCID—18140) **Technical evaluation of the proposed deletion of a reactor trip on a turbine trip below 50-percent power for the Beaver Valley nuclear power plant, Unit 1.** Reeves, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 14p. Dep. NTIS, PC A02/MF A01.

This report documents the technical evaluation of the Duquesne Light Company's proposed license amendment for the deletion of a reactor trip on a turbine trip below 50% power for the Beaver Valley nuclear power plant, Unit 1. This report is supplied as part of the Selected Electrical, Instrumentation, and Control Systems Issues Program being conducted for the US Nuclear Regulatory Commission by Lawrence Livermore Laboratory.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 9691, 10070, 10145, 10148

10055 (GKSS—78/E/49) **Use of tracers in the measurement of fission product transport in graphite.** Melkonian, G.A.; Ruckdeschel, A.; von Geiso, C. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Werkstofftechnologie und Chemie). Nov 1978. 16p. (In German). (CONF-7810177—13). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Lecture meeting on principles and applications of nuclear-, radio-, and radiation chemistry; Lindau, F.R. Germany (16 Oct 1978).

An experimental array was set up which enables concentration profiles to be set up for diffundants in matrix graphite at experimental temperatures equalling reactor conditions (approximately 1000°C); under these conditions, the diffusion of Sr-85 cr Ag-110 from the core of the graphite cylinder into the outer shell is isothermally investigated. In order to determine the concentration profiles, the tracer content of the removed graphite layers is determined by activity measurement. To evaluate the experimental results, the interrelation between the diffusion coefficient and the Einstein displacement square is used. The activation energy of the transfer process can be calculated from the temperature dependence of this quantity.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 10060, 10070, 10149

10056 (STUDSVIK-BL—78/32) **Fission product migration in intact fuel rods. S176 experiments 6 and 7.** Blackadder, W.; Forsyth, R.; Malen, K.; Nilsson, B.A.; Wikstroem, C. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Aug 1978. 67p. Dep. NTIS (US Sales Only), PC A04/MF A01.

This report describes the results for rods 6 and 7 in the S176-series of experiments. The aim of this series is to provide information on the distribution of fission products in intact irradiated fuel rods, both within the UO_2 fuel and on the inside of the Zircaloy clad. Results reported here are from axial gamma scanning, ceramography and radial gamma scanning. Generally the results for rods 6 and 7 complement and confirm the results of the previous experiments in this series. The tellurium distribution in S176-7, however, is remarkably unsymmetrical confirming that the smaller asymetries observed in some cases earlier probably are real.

10057 **Multiple structure-soil interaction problem.** Parker, J.V.; Ahmed, K.M.; Ranshi, A.S. (Nuclear Power Co. (Risley) Ltd. (UK)). pp K2/17 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A nuclear power station generally consists of a complex of different buildings, each having separate foundation rafts and containing a wide range of plant and equipment. In designing these structure against earthquake ground motions dynamic interaction or coupling effects through the ground are frequently ignored, each raft being treated as isolated from any such effects. This coupling effect

is investigated in this paper for a number of different but simple arrangements of nuclear power station structures. The arrangements considered include: (i) Two twin SGHWR nuclear islands on separate foundation rafts. Each raft is 70 m square and the response is calculated for a range of distance between rafts varying from 35 m to 105 m. (ii) A single SGHWR nuclear island plus a fuel handling block on a separate foundation raft.

POWER REACTORS, BREEDING

REFER ALSO TO CITATION(S) 10080, 10103, 10104, 10129, 10134, 10135, 10138, 10139, 10144, 10153, 10320, 10337

10058 (ANL—79-58) **Calculations of stresses in GCFR cladding under normal operating conditions.** Liu, Y.Y.; Hsieh, T.C.; Billone, M.C. (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 54p. Dep. NTIS, PC A04/MF A01.

A modified version of the LIFE-III code, LIFE-GCFR, and classical stress-analysis techniques have been used to calculate the stresses in the GCFR cladding under normal reactor operating conditions. Several types of loadings on the cladding that occur during normal operation have been considered. These include fuel-cladding mechanical interaction, thermal stresses induced by radial and axial temperature gradients, and swelling gradient-induced stresses. The combined and individual effects of these loadings, as well as the effect of creep on cladding stresses, have been assessed.

10059 (ANL—79-70) **Numerical method for solution of transient, homogeneous, equilibrium, two-phase flows in one space dimension.** Shin, Y.W.; Wiedermann, A.H. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A03/MF A01.

A solution method is presented for transient, homogeneous, equilibrium, two-phase flows of a single-component fluid in one space dimension. The method combines a direct finite-difference procedure and the method of characteristics. The finite-difference procedure solves the interior points of the computing domain; the boundary information is provided by a separate procedure based on the characteristics theory. The solution procedure for boundary points requires information in addition to the physical boundary conditions. This additional information is obtained by a new procedure involving integration of characteristics in the hodograph plane. Sample problems involving various combinations of basic boundary types are calculated for two-phase water/steam mixtures and single-phase nitrogen gas, and compared with independent method-of-characteristics solutions using very fine characteristic mesh. In all cases, excellent agreement is demonstrated.

10060 (JAPFNR—472) **Reactor physics activities relevant to FBR and ATR programs in PNC, Japan, November 1978-September 1979.** Inoue, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). 1979. 11p. (PNC-N—241-79-26). Dep. NTIS (US Sales Only), PC A02/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Reactor physics activities have been performed in PNC, Japan, to support FBR and ATR development programs. The experimental fast reactor JOYO attained the second-stage thermal power of 75 MW in July 1979. Environmental impact of the prototype fast breeder reactor, MONJU, is now being assessed by both Japanese government and prefectural government and its construction will be started in 1981. A prototype reactor of heavy water-moderated, boiling light water-cooled, pressure tube type, FUGEN, went into its commercial operation in March 1979.

10061 (JAPFNR—487) **Assessment of generation method of nuclear reactor constants set using the JENDL-2 nuclear data file.** Takano, H.; Nakagawa, M.; Hasegawa, A.; Ishiguro, Y.; Matsui, Y.; Kaneko, K. (Japan Atomic Energy Research Inst., Tokyo). 1979. 67p. (JAERI-Memo—8233; PNC-J—250-79-13). Dep. NTIS (US Sales Only), PC A04/MF A01.

Work performed under United States-Japanese Fast Reactor Exchange Program.

Interpolation method of resonance shielding factor, group collapsing method with bilinear weight, and group structure were assessed for the purpose of generation of new nuclear reactor constants set using the JENDL-2 nuclear data file, and an adjustment plan was proposed for the methodology used. Concerned with the interpolation method of shielding factor, various methods used so far and, additionally, spline fitting method and Akima's method were intercompared in connection with computing accuracy and time. The spline method was found to give the most excellent and stable accuracy. Concerning the bilinear-weight collapsing method, the difference between the flux- and bilinear-weight collapsings was studied by considering a group collapse from seventeen to twenty-five groups and by analyzing reactivity worth measurements for sodium void at ZPPR-2 and steam entry at ZPR-9 Phase 1. The flux-weight collapsing method used so far was shown to be sufficient for the analysis of the measurement of sodium void reactivity worth.

10062 (NUREG/CR—0790, pp 13-24) **Development of a coded aperture fuel motion diagnostics system for the ACPR (UPGRADE).** Kelly, J.G.; Stalker, K.T. (Sandia Labs., Albuquerque, NM). Oct 1979.

In Topical report on fuel motion diagnostic systems.

As part of Sandia Laboratories' program to study simulated core disruptive accidents in reactor safety research, a fuel motion detection system based on coded aperture imaging is being developed for the Annular Core Pulsed Reactor (ACPR). Although fuel motion has been observed at the TREAT by the fast neutron hodoscope and with a Vidicon pinhole camera technique, the coded aperture system offers a potential for lower cost, higher spatial resolution, three dimensional imaging, and higher frame rates at lower fluences than either of the other techniques.

10063 (NUREG/CR—0790, pp 25-38) **Analog and digital reconstructions of fuel pin images recorded with the prototype ACPR (UPGRADE) fuel motion diagnostic system.** Stalker, K.T.; Kelly, J.G. (Sandia Labs., Albuquerque, NM). Oct 1979.

In Topical report on fuel motion diagnostic systems.

A coded aperture imaging system to provide time resolved images of LMFBR fuel rods undergoing simulated core disruptive accidents is being developed at Sandia Laboratories. The imaging results of the SPR-II and ACPR experiments are presented. How the information was decoded from the coded image is discussed. The results of two different methods of image reconstruction are presented and the relative merits of both approaches are discussed.

10064 (NUREG/CR—0790, pp 39-50) **Potential for using coded aperture imaging for fuel motion detection measurement in the STF.** McArthur, D.A.; Halbleib, J.A. Sr.; Morel, J.E.; Kelly, J.G. (Sandia Labs., Albuquerque, NM). Oct 1979.

In Topical report on fuel motion diagnostic systems.

At Sandia Laboratories, coded aperture imaging of both neutrons and γ-rays is being investigated for fuel motion detection in STF as part of the NRC Reactor Safety Research program. Based on work done for the development of a fuel motion detection system for the ACPR UPGRADE, coded aperture imaging of γ-rays will be capable of producing high-resolution images of at least up to seven fuel pins. However, because of the short mean free path of γ-rays in the test fuel, it is not clear that γ-ray imaging can provide useful information in the large-bundle tests to be made in STF. Investigation of these questions in detail has therefore commenced using γ-ray transport codes. Alternatively, fast neutrons have a somewhat longer mean free path than γ-rays, and it may be desirable to image with fast neutrons in the case of larger fuel bundles.

10065 (NUREG/CR—0790, pp 51-62) **Relation between fuel motion and detector response for in-core fuel motion detection systems.** McDaniel, P.J. (Sandia Labs., Albuquerque, NM); Wright, S.A.; Scott, W.H. Jr. Oct 1979.

In Topical report on fuel motion diagnostic systems.

The detection of fuel motion within test sections of reactors which have no slots (SLSF, EBR-II, SCARABEE) requires the use of an in-core fuel motion detection system. In-core systems can also be useful as auxiliary fuel motion monitoring systems for reactor facilities which do have slots. A supplementary in-core fuel motion detection system would be especially useful for large-bundle tests, since self-shielding effects may degrade the resolution of external viewing systems. With support from the US Nuclear Regulatory Commission, an experimental program is being conducted at Sandia to demonstrate the feasibility of in-core fuel motion detection systems. This program has two major developmental efforts. The first requires development of a suitable set of detectors, and the second requires development of analytical methods which can determine fuel motion from detector signals.

10066 (NUREG/CR—0790, pp 63-74) **Flash x-radiography for material motion detection.** Choate, L.M.; Buckalew, W.H.; Posey, L.D. (Sandia Labs., Albuquerque, NM). Oct 1979.

In Topical report on fuel motion diagnostic systems.

The applicability of flash x-ray cinematography for the detection of material motion during reactor safety experiments is being studied at Sandia Laboratories. As part of this study, a comparison is being made between conventional radiographic and coded source radiographic techniques. For the conventional radiographic technique, the effects of photon buildup and photon scattering upon spatial and areal density resolution capabilities in poor geometry situations are being evaluated. Two particular methods of producing a coded radiographic source are under investigation.

10067 (ORNL/TM—7139) **ac power control in the Core Flow Test Loop.** McDonald, D.W. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 102p. Dep. NTIS, PC A06/MF A01.

Thesis.

This work represents a status report on a development effort to design an ac power controller for the Core Flow Test Loop. The Core Flow Test Loop will be an engineering test facility which will simulate the thermal environment of a gas-cooled fast-breeder reactor. The problems and limitations of using sinusoidal ac power to simulate the power generated within a nuclear reactor are addressed. The transformer-thyristor configuration chosen for the Core Flow Test Loop power supply is presented. The initial considerations, design, and analysis of a closed-loop controller prototype are detailed. The design is then analyzed for improved performance possibilities and failure modes are investigated at length. A summary of the work completed to date and a proposed outline for continued development completes the report.

10068 (STUDSVIK-K2—78/43) **General features of the neutronics design code EQUICYCLE.** Jirlow, K. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Oct 1978. 7p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The neutronics code EQUICYCLE has been developed and improved over a long period of time. It is expecially adapted to survey type design calculations of large fast power reactors with particular emphasis on the nuclear parameters for a realistic equilibrium fuel cycle. Thus the code is used to evaluate the breeding performance, the power distributions and the uranium and plutonium mass balance for realistic refuelling schemes. In addition reactivity coefficients can be calculated and the influence of burnup could be assessed. The code is two-dimensional and treats the reactor core in R-Z geometry. The basic ideas of the calculating scheme are successive iterative improvement of cross-section sets and flux spectra and use of the mid-cycle flux for burning the fuel according to a specified refuelling scheme. Normally given peak burn-ups and maximum power densities are used as boundary conditions. The code is capable of handling the unconventional, so called heterogeneous cores.

REGULATION AND LICENSING

REFER ALSO TO CITATION(S) 10200

10069 (NUREG/CR—0569) **Facilitation of decommissioning light water reactors.** Moore, E.B. Jr. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Dec 1979. Contract EY-76-C-06-1830. 80p. Dep. NTIS, PC A05/MF A01.

Information on design features, special equipment, and construction methods useful in the facilitation of decommissioning light water reactors is presented. A wide range of facilitation methods - from improved documentation to special decommissioning tools and techniques - is discussed. In addition, estimates of capital costs, cost savings, and radiation dose reduction associated with these facilitation methods are given.

ECONOMICS

CONSTRUCTION AND OPERATION

REFER ALSO TO CITATION(S) 9612

FUEL CYCLE

REFER ALSO TO CITATION(S) 10469

10070 (CONF-791058—25) **Advanced converter reactors.** Kasten, P.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

Advanced converter reactors (ACRs) of primary US interest are those which can be commercialized within about 20 years, and are: Advanced Light-Water Reactors, Spectral-Shift-Control Reactors, Heavy-Water Reactors (CANDU type), and High-Temperature Gas-Cooled Reactors. These reactors can operate on uranium, thorium, or uranium-thorium fuel cycles, but have the greatest fuel utilization on thorium type cycles. The water reactors tend to operate more economically on uranium cycles, while the HTGR is more economical on thorium cycles. Thus, the HTGR had the greatest practical potential for improving fuel utilization. If the US has 3.4 to 4 million tons U_3O_8 at reasonable costs, ACRs can make important contributions to maintaining a high nuclear power level for many decades; further, they work well with fast breeder reactors in the long term under symbiotic fueling conditions. Primary nuclear data needs of ACRs are integral measurements of reactivity coefficients and resonance absorption integrals.

PROCESS HEAT REACTORS

10071 **Dynamic interaction of components, structure, and foundation of nuclear power facilities.** Pajuhesh, J. (886 Hilgard Ave., West Los Angeles, California 90024, U.S.A.); Hadjian, A.H. (Bechtel Power Corporation, Los Angeles Power Division, Norwalk, P.O. Box 60860 - Terminal Annex, California 90650, U.S.A.). pp K3/9 1-8 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A solution is formulated for the dynamic analysis of structures and components with different stiffness and damping characteristics, including the consideration of soil-structure interaction effects. Composite structures are often analysed approximately, in particular with regards to damping. For example, the reactor and other equipment in nuclear power plant structures are often analysed by assuming them uncoupled from the supporting structures. To achieve a better accuracy, the coupled system is hereby analysed as a composite component-structure-soil system. To demonstrate the assembly technique, two examples are considered: (a) a steel structure sitting on a concrete stem and linked by a steel bridge to another concrete structure, and (b) an actual model of a nuclear power plant containment structure.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 10061, 10389

10072 **Problem of resonance in the evaluation of floor response spectra.** Peters, K.; Schmitz, D.; Wagner, U. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp K4/11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10073 **Effective seismic input through rigid foundation filtering.** Ray, D.; Jhaveri, D.P. (URS/John A. Blume and Associates, Engineers, San Francisco, CA (USA)). pp K2/13 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10074 **Finitc element random vibration method for soil-structure interaction analysis.** Romo-Organista, M.P.; Lysmer, J.; Seed, H.B. (California Univ., Berkeley (USA)). pp K2/3 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Earthquake motions are intrainsically random in nature, and it would be desirable to deveop analytical methods which retain this randomness in both the definition of the design motion and the computed response. The authors present a method of this type. In this procedure the seismic environment is defined directly in terms of the given design response spectrum. Response spectra cannot be used directly for random analysis, thus using extreme value theory a new procedure has been developed for converting the design response spectrum into a design power spectrum. Knowing the design power spectrum the resulting output power spectra and their statistical distribution can be computed by a response analysis of the soil-structure system in the frequency domain. Due to the complexity of soil structure systems, this is most conveniently done by the finite element method. The authors have developed a computer program, PLUSH, which can perform the above procedures. Results obtained by the new method are in excellent agreement with the results of corresponding deterministic analysis. Furthermore, the probabilistic results can be obtained at a fraction of the cost of deterministic results.

10075 **Development of compatible secondary spectra without time histories.** Scanlan, R.H. (Princeton Univ., NJ (USA). School of Engineering and Applied Science); Sachs, K. (Kraftwerk Union A.G., Offenbach am Main (Germany, F.R.)). pp K4/13 1-7 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The respresentative single-degree-of-freedom oscillator which responds to earthquake acceleration Z(t) is well known. The absolute acceleration response of this oscillator can be expressed approximately as a series with terms asub(n)(t), the detailed form of each term a sub(n) accounting for the starting transient from quiescent initial conditions. The largest contributions to a(t) occur for the term asub(n) representing response at the natural structural frequency ωsub(s). Then an approximation for asub(n) for this case is used. Results of the above type have been commented on in other terms in literature. The paper then approximates the mean square acceleration and estimates the maximum acceleration. When the entire process sketched above is reapplied for secondary spectra, it gives results which compare well with those obtained using time histories, though the present results are smoother and more consistent.

10076 Direct evaluation of floor response spectra from a given ground response spectrum. Schmitz, D.; Peters, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp K4/10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10077 Comparison between time-step-integration and probabilistic methods in seismic analysis of a linear structure. Schneeberger, B.; Breuleux, R. (Emch + Berger Bern AG, Gartenstrasse 1, CH-3000 Bern, Switzerland). pp K4/6 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Assuming that earthquake ground motion is a stationary time function, the seismic analysis of a linear structure can be done by probailistic methods using the 'power spectral density function' (PSD), instead of applying the more traditional time-step-integration using earthquake time histories (TH). A given structure was analysed both by PSD and TH methods computing and comparing 'floor response spectra'. The analysis using TH was performed for two different TH and different frequency intervals for the 'floor-response-spectra'. The analysis using PSD first produced PSD functions of the responses of the floors and these were then converted into 'foor-response-spectra'. Plots of the resulting 'floor-response-spectra' show: (1) The agreement of TH and PSD results is quite close. (2) The curves produced by PSD are much smoother than those produced by TH and mostly form an enelope of the latter. (3) The curves produced by TH are quite jagged with the location and magnitude of the peaks depending on the choice of frequencies at which the 'floor-response-spectra' were evaluated and on the choice of TH.

10078 Soil-structure interaction analysis by finite element methods - state-of-the-art. Seed, H.B.; Lysmer, J. (California Univ., Berkeley (USA)). pp K2/1 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Analyses of soil-structure interaction effects during earthquakes for nuclear power plant structures are usually made by one of two methods-either by means of an idealized complete interaction analysis involving consideration of a compatible variation of motion in the structure and the adjacent soil, or by means of an inertial interaction analysis in which the motions in the adjacent soil are assumed to be the same at all points above the foundation depth. For embedded structures, consideration of the variation of motions with depth is essential if adequate evaluations of soil and structural response are to be obtained without undue conservatism. The finite element analysis procedure is particularly well suited for evaluating the response of embedded structures since it can readily provide consideration of the variation of soil characteristics with depth, the different non-linear deformation and energy absorbing capacities of the various soil strata, the variation of motions with depth in accordance with the general principles of engineering mechanics, the three-dimensional nature of the problem and the effects of adjacent structures on each other.

10079 Seismic structural response analysis using consistent mass matrices having dynamic coupling. Shaw, D.E. (D'Appolonia Consulting Engineers, Inc., 10 Duff Road, Pittsburgh, Pennsylvania 15235, U.S.A.). pp K3/4 1-14 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The classical treatment of seismic structural response has been primarily confined to simply coupled or close-coupled dynamic systems utilizing lumped-mass representation of the structural mass distribution. With the continued improvement of discrete or finite element methods of analysis, the use of consistent or equivalent mass matrices which are derived from the same displacement function used for the derivation of elemental stiffness matrices has become more popular, especially for equipment analysis and the analysis of continuum structures. Several examples are presented in order to show comparison of the discrete element and closed-form solutions and the solution obtained using traditional methods. The results of consideration of the structural accelerations to usit support accelerations is shown to lead to larger modal participation factors than would be determined neglecting the dynamic coupling through the mass matrix.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 10157, 10324, 10326, 10371, 10475

10080 (ORNL—5591) Development of techniques for joining fuel rod simulators to test assemblies. Moorhead, A.J.; Reed, R.W. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 35p. Dep. NTIS, PC A03/MF A01.

A unique tubular electrode carrier is described for gas tungsten-arc welding small-diameter nuclear fuel rod simulators to the tubesheet of a test assembly. Both the close-packed geometry of the array of simulators and the extension of coaxial electrical conductors from each simulator hindered access to the weld joint. Consequently, a conventional gas tungsten-arc torch could not be used. Two seven-rod assemblies that were mockups of the simulator-to-tubesheet joint area were welded and successfully tested. Modified versions of the electrode carrier for brazing electrical leads to the upper ends of the fuel pin simulators are also described. Satisfactory brazes have been made on both single-rod mockups and an array of 25 simulators by using the modified electrode carrier and a filler metal with a composition of 71.5 Ag-28 Cu-0.5 Ni.

10081 Judging the validity of crack initiation and crack arrest criteria. Schoenherr, W.; Wilken, K. (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). pp 198-202 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Description of criteria of judgement and their application, effects of weld defects, conclusions from small, medium and large specimens for structural members, critical evaluation of the concepts with a view to material, structure and fabrication.

10082 Quality assurance in arc welding techniques by automatic process control and documentation. Dilthey, U. (Messer Griesheim G.m.b.H., Unterschleissheim (Germany, F.R.)). pp 48-51 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The equipment described in the article is designed for use in the fabrication of nuclear components to control the arc welding parameters of current, are voltage, welding velocity, and temperature. Their design guarantees optimum functioning, and they have integrated system and instrument tests to control their functioning.

10083 Use of newer ultrasonic testing techniques of weld joint testing on primary components. Fischer, E. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp 229-231 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Ultrasonic testing (UT) of welds on primary components, requirements of standards and codes, advanced UT-techniques, use of focused probes (actual dimensions of UT indications), mechanized UT during fabrication, objective recording of UT data.

10084 Site-welding of nuclear primary circuit components and their quality assurance. Ammann, H. (Sulzer Bros. Ltd., Winterthur (Switzerland)). pp 39-44 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The high quality demands made of primary circuit components of nuclear power plants can be fulfilled regarding welding to the same degree on-site as in in the plant. Performance and control of the building site work based on a full quality guarantee promme ensures a quality-guaranteed end product.

10085 Experiences in process inspection of manufacturing heavy reactor components. Augsburger, W.; Boldt, R.; Wimmer, O. (Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (Germany,

F.R.)). pp 13-18 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Detection of non conformities by existing methods of surveillance, adjustment of systems of process inspection, development of examination techniques. Future requirements: Increasing efficiency and rationalization of surveillance at a constant.

10086 Measuring and calculating the temperature curves depending on heating times and distance from weld with induction heating of nuclear components. Barkmann, C.G.; Geisel, H.; Mueller, H.H. (AEG-Elotherm G.m.b.H., Remscheid (Germany, F.R.)). pp 44-47 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The high quality requirements on primary components of nuclear power plants can be met just as easily on-site as in the factory as far as welding is concerned. Planning, realisation and controll of work on site on the basis of a full-scale quality assurance programme guarantee a final product of high quality.

10087 Quality assurance when welding in tubes in steam generator tube sheets. Borghoff, R.; Clausmeyer, H.; Hellendrung, H.; Kintzel, H.; Meier, F. (GHH Gutehoffnungshuette Sterkrade A.G., Oberhausen (Germany, F.R.)). pp 32-37 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Welding of material combination X10 NiCrAlTi 32 20/NiCr 15 Fe, welding preparation, process and equipment for automatic and manual welding, quality system assuring measures (planning documentation, type and scope of tests, system of quality control, documentation).

10088 Technology programme characterization of structural and repair welds for thick walled nuclear pressure vessels. Canonico, D.A. (Oak Ridge National Lab., TN (USA)). pp 120 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978).

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

10089 Welding control during fabrication of primary components. Held, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp 31-32 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Requirements of licensing authority, RSK-guide lines, KTA- and DIN-standards. Welding control as constituent of the quality assurance. Scope, objectives and documentation of the welding control and possible improvements.

10090 Status of quality assurance on welding consumables for the nuclear technique. Jaeckel, M.; Kiefer, H.W.; Linssen, G. (Boehler und Co. A.G., Duesseldorf (Germany, F.R.)). pp 21-30 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Quality assurance, quality control. Rules: ASME code, VdTUEV Merkblatt 1753, miscell, specifications of the general contractors. The figure of manufacturer, supplier sub-supplier. Typical welding filler metals of nuclear technique, multiplicity of table of contents for acceptance testing, manufacture-and distribution documentation, more information flow, less difficulties during order settlement.

10091 Statistical quality evaluation of anchor weldments with the steel lining in concrete containment vessels for nuclear reactors. Krawczyk, J.; Paczynski, A. (Forschungs- und Entwurfszentrum fuer Metallkonstruktion, Warsaw (Poland)). pp 120 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978).

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

10092 Quality assurance planning for welding of reactor components. Martinek, H.; Moelkner, H. (Kraftwerk Union A.G., Erlangen (Germany, F.R.)). pp 12-13 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

For optimum quality and rentability, cooperative quality planning by different departments is necessary before production. In order to avoid additional costs, attention should be paid during construction to an optimum design with regard to welding and testing early preparation of the testing documents (part of the schedule) including a repair plan that might become necessary, preparation of welders, and availability of equipment.

10093 Quality assurance for welding materials. van Nassau, L. (Smit Weld NV, Nijmegen (Netherlands)). pp 18-20 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Organization of quality assurance: orderhandling, production and acceptance testing consumables. Differences in international standards and related requirements, definition of lot size, clear identification of products in all stages of production an application.

10094 Fatigue crack growth of a supposed crack between the instrumentation nipples at the bottom of the BBR pressure vessel. Bazant, E.; Kautz, H.R.; Marci, G. (Babcock - Brown Boveri Reaktor G.m.b.H., Mannheim (Germany, F.R.)). pp 203-207 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Crack growth under static load at elevated temperatures, semi-empirical equation describing this type of crack growth. The results of the review are applied to some practical problems.

10095 Probabilistic seismic analysis of containment liner integrity. Fardis, M.N.; Cornell, C.A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering); Meyer, J.E. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Nuclear Engineering). pp K4/16 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

After determining the dynamic response of the containment to seismic events well beyond the Safe-Shutdown Earthquake, the integrity of the liner under the induced stresses is assessed. The response to Earthquake ground motion is found by respresenting the containment as a distribu'ed mass beam, and considering only the first vibrational mode. The stresses at any point are found them from internal forces, as a combination of the stresses from a shell model (with mainly membrane action) and the stresses from a beam model in which horizontal planes remain plane. The resulting stresses and strains in the liner reveal that although the liner might yield under very high ground accelerations, its high ductility will prevent it from tearing. As the average performance of the liner will be satisfactory, potential localized weak points in it are examined. The seam welds between adjacent liner panels are identified as weak points, and weld defects as potential crack initiators. Statistics concerning the size and frequency of occurrence of weld defects in structures similar to the liner plate are used. The probability that a weld point will become a crack initiator given stress is then calculated. The final result is the probability distribution of crack initiators, and the probability distribution of the total crack length, as a function of peak ground acceleration.

10096 Inelastic seismic response of turbine buildings. Hsiu, F.J. (Bechtel Power Corporation, P.O. Box 1000, Ann Arbor, Michigan 48104, U.S.A.); Hanson, R.D. (Michigan Univ., Ann Arbor (USA)). pp K4/3 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Inelastic design of turbine buildings to withstand a Safe Shutdown Earthquake is one of the most cost effective ways to assure that they will not collapse onto adjacent safety related Category I structures. Application of the Newmark-Hall inelastic response spectra technique to turbine building seismic design is examined analytically for various cases of design. Emphasis is placed on the qualification of the structure to sustain SSF loading at a nuclear power plant site wthout collapse. This investigation of the inelastic design and analysis of turbine buildings due to gravitaty and seismic loading used three common turbine building farming configurations. These structures were designed for various design ductilities using Newmark-Hall inelastic spectrum modification procedure with the NRC Regulatory guide 1.60 design response spectra as a base.

10097 New beam and plate bending elements in finite element analysis. Kawai, T. (Tokyo Univ. (Japan). Inst. of Industrial Science). pp K3/8 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

From the viewpoint of limit analysis of three dimensional plate structures, collapse load can be defined when the bending strength is exhausted. Basing on such consideration new beam and plating bending elements are proposed. A new beam element consists of rigid bars connected by a rotational spring, while a plate element consists of rigid plates with a rotational spring. Size of stiffness matrices of these bending elements are 1/2 of a well known beam bending and 1/3 of triangular plate bending element respectively, and therefore considerable reduction of computing time can be expected in routine finite element analysis of structures with minor penalty in increase of mesh division. The spring constants K in the matrices can be computed theoretically by using the finite difference formula for the curvature based on the second order polynomial approximation. The result of limit analysis of a beam clamped at both ends under a single concentrated load and the results of collapse load analysis of a rectangular plate with unusual boundary conditions are shown. Agreement between calculation and experiment was found to be extremely good. The author believes that the use of these new elements will be especially effective in nonlinear analysis of complex structures. Extended application of these models to in-plane, shell and three dimensional problems were also successful. Dynamic collapse load analysis of simple beam and plate structures is also presented.

10098 Constructing mathematical models of cable tray and support systems to determine seismic response in nuclear plants. Thulin, F.A. Jr. (United States Gypsum Company, Research Center, 1000 East Northwest Highway, Des Plaines, Illinois 60016, U.S.A.). pp K3/11 1-7 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The problem is to construct a stick model with lumped masses representing the cable tray/support system in a nuclear plant subjected to seismic forces. The equivalent physical and geometric properties of the lattice sub-system to be changed into the theoretical stick components must be determined. The effective moment of inertia and shear area of the lattice structure are best ascertained by static load tests; damping ratios, by dynamic tests. Properties of non-lattice components are known from given data or can be readily calculated. Engineering judgement is required to fix the size and location of lumped masses. A study of a steel ladder type cable tray in the transverse direction considered as a plane frame serves to show how a lattice sub-system is changed to a mathematically equivalent stick component.

10099 Standardized seismic design spectra for nuclear plant equipment. Tsai, N.C. (Bechtel Power Corp., San Francisco, CA (USA)); Tseng, W.S. (Offshore Development Engineering, Inc., Berkeley, CA, USA). pp K4/15 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 10380

10100 (KFK—2772) **BR2-capsule irradiation experiment Mol-8c. Destructive post irradiation examination.** Weimar, P.; Keller, K.; Bauer, F. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter). Feb 1979. 129p. (In German). Dep. NTIS (US Sales Only), PC A08/MF A01.

The irradiation experiment Mol-8C has been conceived to measure in pile the fission gas pressure built up. Furtheron, the influence of fabrication porosity (constant smear density) on pin behaviour for two different rod powers should be tested. The first objective was full comprehended. The second point could not be interpreted because of mechanical interaction. Pin No. 9 with zones of changing porosity (88 - 91 - 95% TD) was examined for radial porosity redistribution. The radial porosity redistributions were recalculated by the improved oxide-pin-program SATURN-3. Furtheron, the diameter increase of the claddings were recalculated and compured by SATURN-3.

10101 Turbulence modeling of axial flow in a bare rod bundle. Bartzis, J.G.; Todreas, N.E. (Department of Nuclear Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139). E(11-1)-2245. *J. Heat Transfer;* **101**: No. 4, 628-634(Nov 1979).

Temperature distribution within the rod bundle of a nuclear reactor is of major importance in nuclear reactor design. However temperature information presupposes knowledge of the hydrodynamic behavior of the coolant which is the most difficult part of the problem due to the complexity of the turbulence phenomena. In the present work a two equation turbulence model (a strong candidate for analyzing actual three dimensional turbulent flows) has been used to predict fully developed flow of infinite bare rod bundles of various aspect ratios (P/D). The model has been modified to take into account anisotropic effects of eddy viscosity. Secondary flow calculations have been also performed although the model seems to be too rough to predict the secondary flow correctly. Heat transfer calculations have been performed to confirm the importance of anisotropic viscosity in temperature predictions. Experimental measurements of the distribution of axial velocity, turbulent axial velocity, turbulent kinetic energy and radial Reynolds stresses were performed in the developing and fully developed regions. A two channel Laser Doppler Anemometer working in the reference mode with forward scattering was used to perform the measurements in a simulated interior subchannel of a triangular rod array with P/D=1.124. Comparisons between the analytical results and the results of this experiment as well as other experimental data in rod bundle arrays available in the literature are presented. The predictions are in good agreement with the results for high Reynolds numbers.

10102 Comments on fission-gas release from fuel at high burnup in Vol. 19, No. 6. Ocken, H.; Roberts, J.T.A. (Electric Power Research Inst., Palo Alto, CA). *Nucl. Saf.;* **20**: No. 4, 417-421(Jul 1979).

Includes authors' response.

Meyer, Beyer, and Voglewede have proposed that an enhancement factor be applied to existing vendor models when fission-gas release (FGR) at burnups greater than 20,000 MWd/metric ton is calculated for licensing purposes. This enhancement factor is derived from FGR data obtained from liquid-metal-cooled fast breeder reactor (LMFBR) fuel. The analysis assumes that the intrinsic source of the high FGR measured for some light-water-reactor (LWR) fuel rods is, per se, the burnup. In deriving the enhancement factor, the authors claim that effects on FGR due to differences in operating temperature between LWR and LMFBR fuels have been taken into account. Comments are submitted to suggest that an alternative factor, namely, fuel operating temperature, is the dominant variable that determines FGR. Recent FGR data from LWR fuel rods that support this view are presented.

CONTROL SYSTEMS

10103 (BMFT-FB-K—79-01) **Reversible storage of boron acid.** Eyser, H.; Graemer, G.; Hiller, S.; Wittrowsky, G. (Bundesministerium fuer Forschung und Technologie, Bonn-Bad Godesberg (Germany, F.R.)). Mar 1979. 65p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

Methods for the reversible storage of boron acid with a strong basic ion exchanger were investigated. For high and low pressure systems the operating costs were compared with a fractional destillation un unit of a PWR. A procedure for the determination of the actual boron concentration of the primary water is described, basing on the neutron absorption.

10104 (KFK—2684) **Fluiddynamic investigations with the absorbers of the first and second shut down unit of the SNR-300.** Marten, K.; Hoffmann, H. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter). Jan 1979. 26p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

Two independent shut down systems with different design characteristics will be installed in the SNR-300. The first shut down unit also controls the reactor. It consists of a rigid absorber and operates due to gravity from top downward into the core. The second shut down unit each is composed of three articulated absorbers installed beneath the core and pulled up into the core by acceleration springs. To support the design of the absorbers of the two shut down units the pressure losses, the mass flow distributions and the floating characteristics have been investigated experimentally in water flow. Beside the mass flow rates the main parameters represent the axial and radial positions of the absorber bundles within the guide tube. The transferability of the results to sodium flow is guaranteed.

ENVIRONMENTAL ASPECTS

SITING

REFER ALSO TO CITATION(S) 10159, 10160, 10161, 10162, 10579

10105 (NTIS/PS—79/0792) Offshore structures (A bibliography with abstracts). Report for 1964-July 1979. Habercom, G.E. Jr. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 302p. NTIS PC N01/MF N01.

Offshore structures are investigated relative to their feasibility, design, construction, marine environments, and environmental impact. Nuclear power plants, floating cities, and airports are among the facilities included in the feasibility studies. (This updated bibliography contains 296 abstracts, 57 of which are new entries to the previous edition.)

10106 Strong ground motion spectra for layered media. Askar, A.; Cakmak, A.S.; Engin, H. (Princeton Univ., NJ (USA). School of Engineering and Applied Science). pp K1/13 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

This article presents an analytic method and calculations of strong motion spectra for the energy, displacement, velocity and acceleration based on the physical and geometric ground properties at a site. Although earthquakes occur with large deformations and high stress intensities which necessarily lead to nonlinear phenomena, most analytical efforts to date have been based on linear analyses in engineering seismology and soil dynamics. There are, however, a wealth of problems such as the shifts in frequency, dispersion due to the amplitude, the generation of harmonics, removal of resonance infinities, which cannot be accounted for by a linear theory. The general solution of shear waves in a typical layer is obtained. Based on this latter, transfer matrices for the various harmonics of the motion are constructed by relating the displacement and the stress at one face to those at the other. With the use of these transfer matrices, the solution of a multilayer system is obtained by requiring continuity in the nonlinear displacement and nonlinear stress. Results are presented for case studies in 1, 2 and 3 layers as well as for actual data for a site with 5 layers at Las Vegas.

10107 Response spectrum analysis of coupled structural response to a three component seismic disturbance. Boulet, J.A.M. (Oak Ridge National Lab., TN (USA)); Carley, T.G. (Tennessee Univ., Knoxville (USA). Dept. of Engineering Science and Mechanics). pp K3/5 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The work discussed herein is a comparison and evaluation of several response spectrum analysis (RSA) techniques as applied to the same structural model with seismic excitation having three spatial components. Lagrange's equations of motion for the system were written in matrix form and uncoupled with the modal matrix. Numerical integration (fourth order Runge-Kutta) of the resulting model equations produced time histories of system displacements in response to simultaneous application of three orthogonal components of ground motion, and displacement response spectra for each modal coordinate in response to each of the three ground motion components. Five different RSA techniques were used to combine the spectral displacements and the modal matrix to give approximations of maximum system displacements. These approximations were then compared with the maximum system displacements taken from the time histories. The RSA techniques used are the method of absolute sums, the square root of the sum of the squares, the double sum approach, the method of closely spaced modes, and Lin's method. The vectors of maximum system displacements as computed by the time history analysis and the five response spectrum analysis methods are presented.

10108 Simplified procedure for evaluating modal damping factors in structures with widely varying damping capacities. Brusa, L.; Ciacci, R.; Restelli, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). pp K3/10 1-9 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The dynamic response of composite structures by the modal superposition method can be conveniently performed only if the motion equation are decoupled by proper coordinate transformations. The decoupling of motion equation can be exactly obtained by using the damped complex eigenmodes of the structure. This rigorous procedure results into an expensive computational effort for structures discretized with a large number of degrees of freedom. For this reason some approximate solutions of the problem were proposed requiring only the computation of the undamped modal characteristics of the system. Such techniques are based on the assumption that the damping matrix is diagonalized by the undamped modes so that the following relation holds: $X^{(T)}CX=2\Omega N$ where C is the damping matrix, X is the matrix of the undamped modes, Ω and N are diagonal matrices, whose entries are the undamped frequencies and the equivalent modal damping ratios, respectively. In this paper a simplified procedure for the evaluation of the equivalent modal damping ratios is proposed. This technique is based on the assumption that the complex eigenmodes can be expressed as a linear combination of the first few undamped modes. The coefficient of the linear combination and the approximate frequencies and damping modal factors are computed by solving a reduced generalized eigenvalue problem whose order is equal to the number of undamped modes considered. To evaluate the efficiency of this procedure, a numerical experimentation was performed for the reinforced concrete containment and the internals of a typical pressure water nuclear reactor founded on different soil conditions.

10109 Comparison of artificial and natural earthquake time history functions with regard to their floor response spectra. Busch, K.A.; Wagner, U. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp K4/14 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10110 Experimental and analytical investigations in nonlinear dynamic soil-structure interaction. Chan, C. (Electric Power Research Inst., Palo Alto, CA (USA)); Howard, G.E.; Ibanez, P.; Smith, C.B. (Applied Nucleonics Company, Inc., P.O. Box 24313, Village Station, Los Angeles, California 90024, U.S.A.). pp K2/10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10111 Earthquake analysis of structures including structure-soil interaction by a substructure method. Chopra, A.K. (California Univ., Berkeley (USA)); Guttierrez, J.A. (Department of Civil Engineering, Universidad de Costa-Rica, San Jose, Costa Rica). pp K2/8 1-10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A general substructure method for analysis of response of nuclear power plant structures to earthquake ground motion, including the effects of structure-soil interaction, is summarized. The method is applicable to complex structures idealized as finite element systems and the soil region treated as either a continuum, for example as a viscoelastic halfspace, or idealized as a finite element system. The halfspace idealization permits reliable analysis for sites where essentially similar soils extend to large depths and there is no rigid boundary such as soil-rock interface. For sites where layers of soft soil are underlain by rock at shallow depth, finite element idealization of the soil region is appropriate; in this case, the direct and substructure methods would lead to equivalent results but the latter provides the better alternative. Treating the free field motion directly as the earthquake input in the substructure eliminates the deconvolution calculations and the related assumption-regarding type and direction of earthquake waves-required in the direct method.

10112 Monodimensional schematization of soil for seismic response analysis. Costes, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Surete Nucleaire). pp K2/11 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Soil structure interaction is currently analyzed either by the use of soil springs and dampers derived by the theory of elastic continuum, or by the use of finite element schematization of a certain part of the soil. Limitations of finite element methods are related to the difficulty of simulating non-reflective boundaries for the perturbations coming from the foundation, and to the great number of finite elements required in representative three-dimensional models. A monodimensional model has been applied in a computer program, with the following purposes: - taking account of embedment and of material damping, - obtaining three-dimensional effects with very few finite elements, - investigating the problem of non-reflective boundaries. The program has been applied to a nuclear building and the results are compared to the ones obtained for a flat superficial foundation without damping.

10113 Floor response spectra from spectrum compatible motions. Duff, C.G.; Biswas, J.K. (Atomic Energy of Canada Ltd., Sheridan Park, Ontario. Power Projects). pp K4/12 1-10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Floor response spectra are commonly used for the design of equipment, piping systems, control instruments or other sub-systems

located in nuclear power plants. An artificial or modified real time-history of motion, compatible with a set of ground response spectra, is often used to generate these floor response spectra. This paper shows that even using a modified real time history, closely matching a given ground response spectrum, large-variations of the floor response spectra can result. The paper discusses the cause of such variations and aims at finding ways to deal with them.

10114 Dynamic analysis of embedded structures. Kausel, E. (Stone and Webster Engineering Corp., Boston, MA (USA)); Whitman, R.V. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering); Elsabee, F. (Stone and Webster Engineering Corp., Cherry Hill, New Jersey (USA)); Morray, J.P. (EDS Nuclear Inc., 220 Montgomery Street, San Francisco, California 94104, U.S.A.). pp K2/6 1-10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper presents simplified rules to account for embeddment and soil layering in the soil-structure interaction problem, to be used in dynamic analysis. The relationship between the spring method, and a direct solution (in which both soil and structure are modeled with finite elements and linear members) is first presented. It is shown that for consistency of the results with the two solution methods the spring method should be performed in the following three steps: 1. Determination of the motion of the massless foundation (having the same shape as the actual one) when subjected to the same input motion as the direct solution. 2. Determination of the frequency dependent subgrade stiffness for the relevant degrees of freedom. 3. Computations of the response of the real structure supported on frequency dependent soil springs and subjected at the base of these springs to the motion computed in step 1. The first two steps require, in general, finite element methods, which would make the procedure not attractive. It is shown in the paper, however, that excellent approximations can be obtained, on the basis of 1-dimensional wave propagation theory for the solution of step 1, and correction factors modifying for embeddment the corresponding springs of a surface footing on a layered stratum, for the solution of step 2.

10115 Nonlinear seismic soil-structure interaction analysis of nuclear power plant structures. Khanna, J.K.; Setlur, A.V.; Pathak, D.V. (Fluor Pioneer, Inc., Chicago, IL (USA)). pp K2/5 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The heterogeneous and nonlinear soil medium and the detailed three-dimensional structure are synthesized to determine the seismic response to soil-structure systems. The approach is particularly attractive in a design office environment since it: a) leads to interactive motion at the soil-structure interface; b) uses existing public domain programs such as SAPIV, LUSH and FLUSH with marginal modifications; and c) meets current regulatory requirements for soil-structure interaction analysis. Past methods differ from each other depending on the approach adopted for soil and structure representations and procedures for solving the governing differential equations. Advantages and limitations of these methods are reviewed. In the current approach, the three-dimensional structure is represented by the dynamic characteristics of its fixed base condition. This representation is ideal when structures are designed to be within elastic range. An important criterion is the design of the nuclear power plant structures. Model damping coefficients are varied to reflect the damping properties of different structural component materials. The detailed structural model is systematically reduced to reflect important dynamic behavior with simultaneous storing of intermediate information for retrieval of detailed structural response. Validity of the approach has been established with simple numerical experiments.

10116 Criteria for the generation of spectra consistent time histories. Lin, C.W. (Westinghouse Electric Corp., Pittsburgh, PA (USA). PWR Systems Div.). pp K1/11 1-8 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Several methods are available to conduct seismic analysis for nuclear power plant systems and components. Among them, the response spectrum technique has been most widely adopted for linear type of modal analysis. However, for designs which consist of structural or material nonlinearites such as frequency dependent soil properties, the existance of gaps, single tie rods, and friction between supports where the response has to be computed as a function of time, time history approach is the only viable method of analysis. Two examples of time history analysis are: 1) soil-structure interaction study and, 2) a coupled reactor coolant system and building analysis to either generate the floor response specra or compute nonlinear system time history response. The generation of a suitable time history input for the analysis has been discussed in the literature. Some general guidelines are available to insure that the time history imput will be as conservative as the design response spectra. Very little has been reported as to the effect of the dyanmic characteristics of the time history input upon the system response. In fact, the only available discussion in this respect concerns only with the statitical independent nature of the time history components. In this paper, numerical results for cases using the time history approach are presented. Criteria are also established which may be advantageously used to arrive at spectra consistent time histories which are conservative and more importantly, realistic.

10117 Effect of rotatory inertia on the dynamic response of cantilever structures. Lin, Y.J.; Hadjian, A.H. (Bechtel Power Corporation, Los Angeles Power Division, Norwalk, P.O. Box 60860 - Terminal Annex, Los Angeles, California 90060, U.S.A.). pp K3/13 1-10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The effect of rotatory inertia on the frequencies and dynamic response of cantilever structures subjected to lateral earthquake excitation is thoroughly studied. This is done by using both the consistent and lumped mass matrices and analytical solution. The beam support is treated either as fixed or elastically restrained to consider soil-structure interaction effects.

10118 Evaluation of seismic-resistant design methods for inelastic structures. Mahin, S.A.; Bertero, V.V. (California Univ., Berkeley (USA)). pp K4/2 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10119 Earthquake response of nuclear reactor building deeply embedded in soil. Masao, T.; Hirasawa, M. (Nuclear Power Plant Civil and Architecture Department, Fujita Corporation, 74 Oodana, Kohoku-ku, Yokohama 233, Japan); Yamamoto, S.; Koori, Y. (Technical Research Laboratory, Chiyoda Chemical Engineering and Construction Corporation, Ikegaminita, Kawasaki 210, Japan). pp K2/7 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Regarding the earthquake response of nuclear reactor building embedded in soil, experimental and theoretical investigations has been performed on a model of height-3.75 meter, bottom cross section-5x5 meter, weight-173 ton made of conrete under the financial support of Japanese government (The Science and Technology Agency). The top of model was excited by an eccentric mass vibration that can generate maximum force of 3 tons. Earthpressures were measured at the bottom and side wall of model, and displacements were also measured at the top of model (6 components) and ground surface changed in the steps which were 0, 20, 47, 73, 100% (against the height of model). Using these experimental results and soil properties, dynamical characteristics were studied, including resonant frequency, radiation damping, vibrational mode, frequency response and earthpressure distribution around the model at varying embedment by lumped model, cyclindrical elastic wave model and FEM models (thin layer elements).

10120 Post-earthquake evaluation of nuclear piping systems. Matzen, V.C.; McNiven, H.D. (California Univ., Berkeley (USA)); Mayes, R.L. (COMPUTECH, 2150 Shattuck Avenue, Berkeley, California 94704, U.S.A.). pp K3/7 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10121 Comments on earthquake response spectra. Mohraz, B. (Southern Methodist Univ., Dallas, TX (USA)). pp K1/6 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10122 Inelastic design of nuclear reactor structures and its implications on design of critical equipment. Newmark, N.M. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). pp K4/1 1-10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Based on research and experience in Earthquake Engineering, criteria applicable to the seismic design of nuclear power plant

facilities are described, including selection of the earthquake hazard for design, earthquake ground motions, soil-structure interaction, damping and energy absorption in structural and equipment response, methods of dynamic analysis for design, and design procedures for structure and equipment. These criteria differ somewhat from the design criteria of the U.S. Atomic Energy Commission and its successor, the U.S. Nuclear Regulatory Commission. The major differences involve, among other things, the possibility of designing into the nonlinear or inelastic range.

10123 Modeling of slabs in seismic analysis of nuclear power plant buildings. Perumalswami, P.R.; Dalal, J.S. (United Engineers and Constructors, Inc., Philadelphia, PA (USA)). pp K3/12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10124 Seismic risk maps of Switzerland. Saegesser, R.; Rast, B.; Merz, H. (Basler and Hofmann, Consulting Engineers, Forchstrasse 395, CH-8029 Zuerich, Switzerland). pp K1/3 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Seismic Risk Maps of Switzerland have been developed under the auspices of the Swiss Federal Division on Nuclear Safety. They are primarily destined for the use of owners of future nuclear power plants. The results will be mandatory for these future sites. The results will be shown as contourmaps of equal intensities for average return periods of 500, 1 000, 10 000... years. This general form will not restrict the use of the results to nuclear power plants only, rather allows their applicability to any site or installation of public interest (such as r.a. waste deposits, hydropower plants, etc.). This follows the recommendations of the UNESCO World Conference (Paris, February 1976). In the study MSK 64 INTENSITY was chosen. The detailed scale allowed a precise handling of historical data and separates the results from continuously changing state of the art correlations to acceleration and other input motion parameters. The method used is the probabilistic theory developed by C.A. Cornell and others at MIT in the late 1960's with the program in the version of the US Geological Survey by R. McGuire.

RADIOACTIVE EFFLUENTS

REFER ALSO TO CITATION(S) 10552, 10592

10125 Radioactive effluents from nuclear power stations and fuel reprocessing plants in Europe, 1972 to 1976. Davis, W. Jr. (Oak Ridge National Lab., TN). *Nucl. Saf.;* **20**: No. 4, 468-475(Jul 1979).

Data on the radioactive gasborne and liquid effluents from 58 nuclear power stations and 7 fuel reprocessing plants in the European Community for the years 1972 to 1976 are presented. There are wide variations in releases from both reactor stations and fuel reprocessing plants because of differences in reactor type, plant size, power levels, and effluent treatment levels. Data covering specific isotopes of particular interest are summarized. In nearly all cases, releases of radioactivity were below maximum applicable values or the treatments used were considered to satisfy the requirement that the best practicable means be used to minimize the amount of radioactivity discharged.

10126 Radioactive materials released from nuclear power plants in 1977. Decker, T.R. (Nuclear Regulatory Commission, Washington, DC). *Nucl. Saf.;* **20**: No. 4, 476-482(Jul 1979).

Releases of radioactive materials in airborne and liquid effluents from commercial light-water reactors during 1977, as well as data on solid-waste shipments, have been compiled and reported. This report supplements earlier ones issued by the former Atomic Energy Commission and the Nuclear Regulatory Commission. The 1977 release data are compared with the releases of previous years in tabular form. Data covering specific radionuclides are summarized.

CHEMICAL AND THERMAL EFFLUENTS

REFER ALSO TO CITATION(S) 10673, 10674, 10675, 10676

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 10060, 10062, 10063, 10064, 10065, 10141, 10886

10127 (AECL—6454) **Homogeneous cell parameters for 2-D reactor codes by axial averaging of the third dimension.** Heeds, W.; Irish, J.D. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Nov 1978. 54p. Dep. NTIS (US Sales Only), PC A04/MF A01.

The NRU and NRX research reactors at Chalk River Nuclear Laboratories are very heterogeneous. Analyses of these reactors are performed using "equivalent" axially averaged homogeneous cell parameters for every lattice site. This allows a 2-D neutron diffusion code to be used to calculate flux distributions, fuel powers and eigenvalues. The axially averaged parameters are obtained from the code CELDATA which calculates "equivalent" homogeneous parameters for a cylindrical cell surrounded by two concentric environment annuli using neutron diffusion and perturbation theories in R, Z geometry. Reaction rates, neutron flux distributions and eigenvalues calculated by CELDATA, for both the axially heterogeneous central cell and its homogeneous "equivalent" are compared for three examples. Some of the NRU loops contain bundles with azimuthal variations in the outer fuel ring. An empirical method is presented whereby the individual element powers for a bundle of this type can be obtained by making corrections to the outer element powers calculated for a bundle with elements of an average composition. The method is tested against an experiment performed in the ZED-2 reactor.

10128 (ORNL/TM—7113) **Oak Ridge research reactor. Quarterly report, April-June 1979.** Hurt, S.S. III; Lance, E.D. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 31p. Dep. NTIS, PC A03/MF A01.

The ORR operated at an average power level of 29.9 MW for 77.9% of the time during April, May, and June of 1979. The reactor was shut down on seven occasions, two of which were unscheduled. Reactor downtime needed for refueling, maintenance and checks was normal, with the reactor remaining available for operation 86.5% of the time. Maintenance activities, both mechanical and instrument, were essentially routine in nature.

10129 (UAC—41069) **Control of oxygen, hydrogen, and tritium in sodium systems at Experimental Breeder Reactor II.** Osterhout, M.M. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

The source rates and steady-state concentrations have been measured for oxygen, hydrogen, and tritium impurities in EBR-II sodium systems. An analytical approach is used to determine the effectiveness of the cold traps for removing oxygen, hydrogen, and tritium. The cold-trap effectiveness data accumulated to date for removal of oxygen, hydrogen, and tritium indicate that EBR-II cold traps are highly effective in controlling these impurities to very low concentrations in the sodium systems.

PLUTONIUM AND ISOTOPE PRODUCTION REACTORS

REFER ALSO TO CITATION(S) 10592, 10673, 10674, 10675, 10676

10130 (DOE/EC/1021—1(Vol.2)) **Savannah River Plant Low-Level Waste Heat Utilization Project preliminary analysis. Volume II. Options for capturing the waste heat.** (South Carolina Energy Research Inst., Columbia (USA)). Nov 1978. Contract EC-77-C-09-1021. 520p. Dep. NTIS, PC A22/MF A01.

Options for utilizing the heated SRP effluent are investigated. The temperature and availability characteristics of the heated effluent are analyzed. Technical options for energy recovery are discussed. A number of thermodynamic cycles that could generate electrical power using the energy in the heated SRP effluent are described. Conceptual designs for SRP application of two attractive options are presented. Other direct uses for the heated effluent, as heat sources for agriculture and aquaculture options are discussed.

10131 (DOE/EC/1021—1(Vol.3)) **Savannah River Plant Low-Level Waste Heat Utilization Project preliminary analysis. Volume III. Preferred utilization options.** (South Carolina Energy Research Inst., Columbia (USA)). Nov 1978. Contract EC-77-C-09-1021. 308p. Dep. NTIS, PC A14/MF A01.

The technical, economic, environmental, and institutional considerations that must be resolved before implementing options to recover energy from the heated SRP effluent are examined. Detailed hypothetical siting options and expected economic returns are examined for power generation, prawn production, and one industrial park scenario. The likely indirect effects on regional population, income, taxes, and infrastructure requirements if the industrial park scenario is implemented are also projected. Recommendations for follow-on studies to make possible an informed go/no-go decision for implementing attractive waste heat options using reject SRP effluent are included.

10132 (DOE/SR/1021—1(Vol.1)) **Savannah River Plant Low-Level Waste Heat Utilization Project preliminary analysis. Volume I. Executive summary.** (South Carolina Energy Research Inst., Colum-

bia (USA)). Nov 1978. Contract EC-77-C-09-1021. 102p. Dep. NTIS, PC A06/MF A01.

A preliminary feasibility study of capturing energy ejected in hot water at the Savannah River Plant (SRP) is presented. The cooling water, drawn from the river or a pond at the rate of 500,000 gallons per minute, is typically heated 80°F to about 150°F and is then allowed to cool in the atmosphere. The energy added to the water is equivalent to 20 million barrels of oil a year. This study reports that the reject heat can be used directly in an organic Rankine cycle system to evaporate fluids which drive electric generators. The output of one reactor can produce 45,000 kilowatts of electricity. Since the fuel is waste heat, an estimated 45% savings over conventional electric costs is possible over a thirty year period.

PROPULSION REACTORS

10133 Nuclear propulsion apparatus with alternate reactor segments. Szekely, T. (to Dept. of Energy). US Patent 4,147,590. 3 Apr 1979. Filed date 1 Sep 1965. 12p.

PAT-APPL-484,488.

Nuclear propulsion apparatus comprising: (a) means for compressing incoming air; (b) nuclear fission reactor means for heating said air; (c) means for expanding a portion of the heated air to drive said compressing means; (d) said nuclear fission reactor means being divided into a plurality of radially extending segments; (e) means for directing a portion of the compressed air for heating through alternate segments of said reactor means and another portion of the compressed air for heating through the remaining segments of said reactor means; and (f) means for further expanding the heated air from said drive means and the remaining heated air from said reactor means through nozzle means to effect reactive thrust on said apparatus. 12 claims.

REACTOR SAFETY

10134 (ANL—79-91) **LIMBO computer code for analyzing coolant-voiding dynamics in LMFBR safety tests.** Bordner, G.L. (Argonne National Lab., IL (USA)). Oct 1979. Contract W-31-109-ENG-38. 34p. Dep. NTIS, PC A03/MF A01.

The LIMBO (liquid metal boiling) code for the analysis of two-phase flow phenomena in an LMFBR reactor coolant channel is presented. The code uses a nonequilibrium, annular, two-phase flow model, which allows for slip between the phases. Furthermore, the model is intended to be valid for both quasi-steady boiling and rapid coolant voiding of the channel. The code was developed primarily for the prediction of, and the posttest analysis of, coolant-voiding behavior in the SLSF P-series in-pile safety test experiments. The program was conceived to be simple, efficient, and easy to use. It is particularly suited for parametric studies requiring many computer runs and for the evaluation of the effects of model or correlation changes that require modification of the computer program. The LIMBO code, of course, lacks the sophistication and model detail of the reactor safety codes, such as SAS, and is therefore intended to compliment these safety codes.

10135 (ANL-RDP—86) **Reactor development program. Progress report, August 1979.** Massey, W.E.; Kyger, J.A. (Argonne National Lab., IL (USA)). 15 Oct 1979. Contract W-31-109-ENG-38. 86p. AT.

Progress is summarized in the following research and development areas: Safety, Physics, Gas Cooled Breeder Reactor, and Test Facilities.

10136 (CONF-791131—1) **Three Mile Island in perspective.** Trauger, D.B. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 12p. Dep. NTIS, PC A02/MF A01.

From Joint meeting of AICHE, ASME, and IEEE; Paducah, KY, USA (13 Nov 1979).

The events of March 28 are described briefly. Some of the causes, for example, failures due to men, to machines, and to man-machine interfaces are discussed. Some plans and actions now being taken to improve things for the future are outlined.

10137 (EGG-TFBP—5027) **Power cooling mismatch test series Test PR-1: experiment operating specification.** Garner, R.W.; Sparks, D.T. (Idaho National Engineering Lab., Idaho Falls (USA)). Oct 1979. Contract EY-76-C-07-1570. 59p. Dep. NTIS, PC A04/MF A01.

The facility operating specifications are described for the PCM-RIA-1 (PR-1) Test. Test PR-1 will involve: steady state operation to provide power calibration information, a series of power cooling mismatch (PCM) DNB cycles induced by reduction in coolant flow rate and a series of Reactivity Insertion (RIA) power excursions. In addition, steady state and power oscillation gap conductance data will be obtained to extend the data base for evaluating the effects of fuel pellet density, initial gap width, and gap gas composition on gap conductance.

10138 (GA-A—15551) **Natural convection effects in a GCFR subassembly during loss of flow with scram conditions.** Croft, M.Z.; Del Bene, J.V.; Torri, A. (General Atomic Co., San Diego, CA (USA)). Oct 1979. Contract EY-76-C-03-0167-023. 13p. (CONF-790816—85). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

Natural convection in a full length GCFR fuel assembly was investigated by experiment and analysis. Non-convecting analysis is shown to be in substantial disagreement with experiment. A new natural convection model using the SCORIA code for GCFR fuel assemblies and the COBRA-IV model for natural convection is presented. The SCORIA/COBRA analytic predictions agree much better with the experiment. The remaining differences are qualitatively explainable.

10139 (GA-A—15556) **Event sequence quantification for a loss of shutdown cooling accident in the GCFR.** Frank, M.; Reilly, J. (General Atomic Co., San Diego, CA (USA)). Oct 1979. Contract EY-76-C-03-0167-023. 14p. (CONF-790816—84). Dep. NTIS, PC A02/MF A01.

From International meeting on fast reactor safety technology; Seattle, WA, USA (19 Aug 1979).

A summary is presented of the core-wide sequence of events of a postulated total loss of forced and natural convection decay heat removal in a shutdown Gas-Cooled Fast Reactor (GCFR). It outlines the analytical methods and results for the progression of the accident sequence. This hypothetical accident proceeds in the distinct phases of cladding melting, assembly wall melting and molten steel relocation into the interassembly spacing, and fuel relocation. It identifies the key phenomena of the event sequence and the concerns and mechanisms of both recriticality and recriticality prevention.

10140 (GRS-F—72) **List of reports from reactor safety research of BMFT, USNRC, EPRI and JSTA. Period under report: 1st October to 31st December 1978.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). Jan 1979. 41p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

This list reviews reports from the Federal Republic of Germany, from the USA and from Japan concerning special problems in the field of Reactor Safety Research. According to the cooperation of the Bundesminister fuer Forschung und Technologie (BMFT) with the USNRC, the Electric Power Research Institute (EPRI), and the Japan Science and Technology Agency (JSTA) these reports are available in the Gesellschaft fuer Reaktorsicherheit. The list pursues the following order: Country of origin, problem area concerned, according to the Reactor Safety Research Program of BMFT, reporting organisation. The list of reports appears quarterly. Requests for reports should be adressed to GRS, Forschungsbetreuung. Contractual view points have to be considered for the distribution of the reports.

10141 (HEDL-SA—1868) **Effects of transient power histories on the intrasubassembly failure incoherencies.** Yung, S.C. (Hanford Engineering Development Lab., Richland, WA (USA)). Sep 1979. Contract EY-76-C-14-2170. 51p. (CONF-791103—64). Dep. NTIS, PC A04/MF A01.

From American Nuclear Society meeting; San Francisco, CA, USA (12 Nov 1979).

The effects of different transient power histories on the intrasubassembly failure incoherencies in an unprotected Transient Overpower (TOP) Hypothetical Core Disruptive Accident (HCDA) are analyzed. The computational tool and other relevant points of present analysis are described. The computational results from the analysis are also discussed. The summary of the present study is stated.

10142 (INIS-mf—4860) **Upgrading safety documentation for exported nuclear power plants.** Rosen, M. (International Atomic Energy Agency, Vienna (Austria)). 1978. 9p. (CONF-781022—81). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting on nuclear power reactor safety; Brussels, Belgium (16 Oct 1978).

In view of the generally small regulatory staffs of importing countries, suggestions are given for upgrading the "export edition" of the traditionally supplied safety documentation by use of a Supplementary Information Report, written specifically for the needs of a smaller and/or less technically qualified staff, which would highlight the differences that exist between the facility to be constructed and the supposedly similar reference plant of the supplier country; by improvement of supporting safety documentation to allow for adequate understanding of significant safety parameters; and by attention to the needs of smaller countries in the critical operating regulations (Technical Specifications for Operation).

10143 (INIS-mf—5005) **Nuclear power in Baden-Wuerttemberg. Importance - problems - tasks.** Grupe, H. (Kernforschungszentrum

Karlsruhe G.m.b.H. (Germany, F.R.). Stabsstelle Oeffentlichkeitsarbeit). (Ministerium fuer Wirtschaft, Mittelstand und Verkehr Baden-Wuerttemberg, Stuttgart (Germany, F.R.)). 1978. 123p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

The whole nuclear power complex is presented in popular form. As is normal in information leaflets, many problems new in public discussion are dealt with. Finally, a short survey is given of the role of nuclear power in Baden-Wuerttemberg. The necessary facts are supplied by many data and figures in the appendix.

10144 (JAPFNR—473) **Activities in SBL-FPL loops for safety study of LMFBR(I).** (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). Jun 1979. 21p. (PNC-N—941-79-79). Dep. NTIS (US Sales Only), PC A02/MF A01.

Work peformed under USDOE-PNC FBR Information Exchange.

As the first step for the safety study of LMFBR, it is necessary to understand the initial events of possible accidents in LMFBR. Local faults and sodium boiling can be considered in that area. SBL and FPL were constructed to understand such phenomena experimentally. Two loops own jointly the dump tank and the purification loop. SIENA is the generic name to both loops. A schematic diagram of SIENA is presented.

10145 (Juel-Spez—19) **Safety study for high temperature reactors under German site conditions. Results of phase Ia 'Review of AIPA-Study'.** Kroeger, W.; Altes, J.; Ashworth, F.P.O.; Badur, A.; Bongartz, R.; David, P.H.; Doehler, J.; Kasper, K.; Linnertz, P.; Meister, G. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung). Aug 1978. vp. (In German). Fachinformationszentrum, Karlsruhe.

This report summarizes the results of a comprehensive review of the American AIPA Study which is an assessment of the risk in accident conditions for the HTGR-1160 design. This review has shown, that the accident sequences following 'Reheater Leaks', 'Loss of Offsite Power' and 'Earthquake', with the latter two leading to core heat-up, are certainly dominant contributors and that the medium risk values should be increased by up to two orders of magnitude. Certain inadequacies of data and methods are apparent and the risk values for accidents such as 'Water Ingrees' and 'Failure of Large PCRV-Closures' are significant and cannot, as in AIPA, be excluded. Neverthelness, the maximum risk value of about 10^{-6}/a is still relatively low due to the intrinsic safety characteristics of the HTR. These are demonstrated in the slow rise of core temperatures and in the slow development of severe accident conditions.

10146 (Juel-Spez—24) **Safety philosophy and research program of the LWR development in the Federal Republic of Germany.** Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Nov 1978. 16p. (In German). (CONF-781022—105; INKA-Conf—78-328-001). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting on nuclear power reactor safety; Brussels, Belgium (16 Oct 1978).

In this paper the framework of the reactor safety concept in the Federal Republic of Germany will be described. It is grounded on several cornerstones the most important of which are a closed fuel cycle concept, a statutory licensing and supervision procedure, a set of compulsory safety-engineering requirements and comprehensive research in the field of reactor-safety. The main part of this last area is the Reactor Safety Research Program sponsored by the Federal Minister for Research and Technology. Furthermore, in this paper emphasis is laid on safety requirements particularly with regard to the quality of the reactor pressure vessel.

10147 (KFK—2761) **Fault tree analysis with multistate components.** Caldarola, L. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Feb 1979. 49p. (EUR—5756e). Dep. NTIS (US Sales Only), PC A04/MF A01.

A general analytical theory has been developed which allows one to calculate the occurence probability of the top event of a fault tree with multistate (more than states) components. It is shown that, in order to correctly describe a system with multistate components, a special type of Boolean algebra is required. This is called 'Boolean algebra with restrictions on varibales' and its basic rules are the same as those of the traditional Boolean algebra with some additional restrictions on the variables. These restrictions are extensively discussed in the paper. Important features of the method are the identification of the complete base and of the smallest irredundant base of a Boolean function which does not necessarily need to be coherent. It is shown that the identification of the complete base of a Boolean function requires the application of some algorithms which are not used in today's computer programmes for fault tree analysis. The problem of statistical dependence among primary components is discussed. The paper includes a small demonstrative example to illustrate the method. The example includes also statistical dependent components.

10148 (NUREG/CR—1136) **High-temperature gas-cooled reactor safety studies for the Division of Reactor Safety Research. Quarterly progress report, July 1-September 30, 1979.** Ball, S.J.; Cleveland, J.C.; Conklin, J.C. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 16p. (ORNL/NUREG/TM—366). Dep. NTIS, PC A02/MF A01.

Further development work was done on the ORTAP and BLAST codes. A new and improved model of the Fort St. Vrain (FSV) reactor turbine-generator plant (ORTURB) was developed for use both as a stand-alone code and as a part of the ORTAP system code. Additional work was done on FSV licensing questions. The intermediate heat transfer experiment for investigating FSV upper-plenum reverse-flow plumes was assembled and checked, and an on-line computer was set up to acquire and analyze the data.

10149 (NUREG/CR—1163) **PCI fuel failure analysis: a report on a cooperative program undertaken by Pacific Northwest Laboratory and Chalk River Nuclear Laboratories.** Mohr, C.L.; Pankaskie, P.J.; Heasler, P.G.; Wood, J.C. (comps.). (Battelle Pacific Northwest Labs., Richland, WA (USA); Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Dec 1979. Contract EY-76-C-06-1830. 134p. (PNL—2755). Dep. NTIS, PC A07/MF A01.

Reactor fuel failure data sets in the form of initial power (P/sub i/), final power (P/sub f/), transient increase in power (ΔP), and burnup (Bu) were obtained for pressurized heavy water reactors (PHWRs), boiling water reactors (BWRs), and pressurized water reactors (PWRs). These data sets were evaluated and used as the basis for developing two predictive fuel failure models, a graphical concept called the PCI-OGRAM, and a nonlinear regression based model called PROFIT. The PCI-OGRAM is an extension of the FUELOGRAM developed by AECL. It is based on a critical threshold concept for stress dependent stress corrosion cracking. The PROFIT model, developed at Pacific Northwest Laboratory, is the result of applying standard statistical regression methods to the available PCI fuel failure data and an analysis of the environmental and strain rate dependent stress-strain properties of the Zircaloy cladding.

10150 (STUDSVIK-K4—79/06) **Studies of fuel models. MOXY-calculations with cracks of the claddings of separated fuel rods in a BWR element.** Jonsson, T.; Kilter, J. (Studsvik Energiteknik AB, Nykoeping (Sweden)). Feb 1979. 10p. (In Swedish). Dep. NTIS (US Sales Only), PC A02/MF A01.

There are essential differencies in the probabilities for the different fuel rods of a BWR element to crack during emergency cooling due to LOCA. Previously it has not been possible to take this fact into account when using the computer code MOXY for sensitivity analyses.

10151 Advisory Committee on Reactor Safeguards: its role in nuclear safety. Lawroski, S. (Argonne National Lab., IL); Moeller, D.W. *Nucl. Saf.;* **20**: No. 4, 387-399(Jul 1979).

For over 25 years the Advisory Committee on Reactor Safeguards (ACRS) has had a continuing responsibility for conducting independent reviews and evaluations of the health and safety aspects of nuclear power reactors, spent-fuel reprocessing plants, and associated activities, which include evaluation of abnormal occurrences and proposed changes at operating facilities, the adequacy of related safety standards and criteria, the adequacy of the related safety research programs, and specific generic questions, such as the reliability of reactor pressure vessels. The ACRS normally issues 40 to 50 reports on specific nuclear facilities and safety-related questions each year. Topics discussed in this article include the views and thoughts of the ACRS with respect to emergency core-cooling systems, anticipated transients without scram, reactor pressure vessel failure, turbine missiles, steamline breaks, seismicity, environmental monitoring, emergency planning, waste management, siting, and reactor safety research.

10152 1978 ACRS critique of NRC safety research program. *Nucl. Saf.;* **20**: No. 4, 399-401(Jul 1979).

10153 Mechanistic analysis of LMFBR accident energetics. Boudreau, J.E. (Los Alamos Scientific Lab., NM). *Nucl. Saf.;* **20**: No. 4, 402-413(Jul 1979).

The state of the art is reviewed for liquid-metal-cooled fast breeder reactor (LMFBR) postdisassembly energetics analysis. Previous attempts have provided bounding and conservative efficiency estimates for converting fission energy into primary-system damage. However, calculational results using the SIMMER-II code indicate that current US primary-system designs may withstand substantially larger reactivity insertion rates than previously thought. Detailed results are presented for the energetics resulting from a voided-core expansion, along with a discussion of code-verification activities.

Further results are presented for expansions involving other initial and boundary conditions, and the importance of the sodium initially present in the core is defined. Finally, the range of reactivity insertion rates that the primary system can accommodate is estimated for the voided-core case, and the remaining technical issues are defined.

10154 Competing risk presentation of reactor safety studies. Thompson, W.A. Jr. (Union Carbide Corp., Oak Ridge, TN). *Nucl. Saf.;* 20: No. 4, 414-417(Jul 1979).

Competing risk theory hypothesizes a number of risks (diseases, accidents, etc.) which compete for the lives of individuals. Each individual will die from one of these risks, and the theory predicts the consequence of removing or adding a risk. The risk of early fatalities from a nuclear accident is examined in comparison to motor vehicle fatality probabilities. (HDR)

10155 Anticipated transients without scram for light-water reactors. Thadani, A.C.; Hagen, E.W. *Nucl. Saf.;* 20: No. 4, 422-433(Jul 1979).

This article summarizes an NRC staff report (NUREG-0460) which reviews and evaluates the information now available on the subject of anticipated transients without scram (ATWS), in particular, the material developed subsequent to the publication of the previous status reports by the staff, which were criticized by the nuclear industry. Report NUREG-0460 is, in part, a response to that industry criticism; it is a statement of the current position of the DSS staff regarding the treatment of ATWS events in the safety evaluation of nuclear power plants and an exposition of the bases for that position. The staff recommends the provision of systems to mitigate the consequences of ATWS events, should they occur, as the most promising alternative for meeting the safety objective. The report consists of the main body of text, appendixes in which the details of the bases for the staff's proposed recommendations are discussed, and a supplement which proposes a course of action for resolving problems relating to ATWS.

10156 Preliminary report on the Three Mile Island incident. Casto, W.R.; Cottrell, W.B. (Oak Ridge National Lab., TN). *Nucl. Saf.;* 20: No. 4, 483-490(Jul 1979).

About 4:00 a.m. on March 28, 1979, Unit 2 at the Three Mile Island Nuclear Power Station experienced a turbine trip. The subsequent sequence of events involving human errors, design deficiencies, and equipment failures resulted in an accident unique in reactor operating experience to date. Although no one was injured by this incident, it has resulted in increased concern for the nuclear option and has prompted numerous investigations. This preliminary report summarizes the status of the plant and related activities through April 30, primarily on the basis of information from Nuclear Regulatory Commission (NRC) press releases, Preliminary Notification of Occurrence memorandums, and Inspection and Enforcement bulletins.

10157 Inelastic seismic studies of buildings. Gauvain, J.; Livolant, M.; Hoffmann, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). pp K4/4 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10158 Cyclic characteristics of earthquake time histories. Hall, J.R. Jr; Shukla, D.K.; Kissenpfennig, J.F. (D'Appolonia Consulting Engineers, Inc., European Operations, Avenue du Jonc, B-1180 Brussels, Belgium). pp K1/7 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

From an engineering standpoint, an earthquake record may be characterized by a number of parameters, one of which is its 'cyclic characteristics'. The cyclic characteristics are most significant in fatigue analysis of structures and liquefaction analysis of soils where, in addition to the peak motion, cyclic buildup is significant. Whereas duration peak amplitude and response spectra for earthquakes have been studied extensively, the cyclic characteristics of earthquake records have not received an equivalent attention. Present procedures to define the cyclic characteristics are generally based upon counting the number of peaks at various amplitude ranges on a record. This paper presents a computer approach which describes a time history by an amplitude envelope and a phase curve. Using Fast Fourier Transform Techniques, an earthquake time history is represented as a projection along the x-axis of a rotating vector-the length the vector is given by the amplitude spectra-and the angle between the vector and x-axis is given by the phase curve. Thus one cycle is completed when the vector makes a full rotation. Based upon Miner's cumulative damage concept, the computer code automatically combines the cycles of various amplitudes to obtain the equivalent number of cycles of a given amplitude. To illustrate the overall results, the cyclic characteristics of several real and synthetic earthquake time histories have been studied and are presented in the paper, with the conclusion that this procedure provides a physical interpretation of the cyclic characteristics of earthquakes.

10159 Shear stress distribution due to shear and Rayleigh wave propagation at deep soil sites. Hall, J.R. Jr.; Shukla, D.K.; Kissenpfenning, J.F. (D'Appolonia Consulting Engineers, Inc., European Operations, Avenue du Jonc 2, B-1180, Brussels, Belgium). pp K1/15 1-9 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Earthquake strong motion at ground surface may be described as the combined result of body (compression and shear) waves and surface waves. In the course of earthquake engineering site response analyses, it is usually assumed that surface motions are a result of vertically propagating body waves. In studies of liquefaction potential, it is assumed that soil shear strains are a result of vertically propagating shear waves. However, shear strains are also caused by surface Rayleigh waves and solutions to strains from each source are derived and compared in the paper, and the results for shear strain in terms of surface acceleration and wave length are presented in non-dimensional form. The results of this investigation show that the distribution of soil shear strain as a function of depth below the ground surface is different depending upon whether shear waves or Rayleigh waves are assumed to be the source of horizontal motions at the ground surface.

10160 Determination of seismic design criteria. Jennings, P.C. (California Inst. of Tech., Pasadena (USA). Div. of Engineering and Applied Science). pp K1/1 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10161 Effects of soil-structure interaction modeling techniques on in-structure response spectra. Johnson, J.J.; Wesley, D.A.; Almajan, I.T. (General Atomic Co., San Diego, CA (USA)). pp K2/12 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The seismic design of nuclear power plant components is normally based on in-structure response spectra generated from an overall plant analysis which accounts for soil-structure interaction. For preliminary design, it is desirable to consider a broad range of site conditions which requires an economical analysis of the soil-structure interaction phenomenon. The purpose of this paper is to compare the results obtained from a simplified approach utilizing stiffness proportional composite damping with those obtained utilizing more refined representations of the soil-structure interaction phenomenon. Thereby, the limits of applicability of the simplified approach are determined. The structure considered for this investigation consisted of the reactor containment building (RCB) and prestressed concrete reactor vessel (PCRV) for a HTGR plant. A conventional lumped-mass dynamic model in three dimensions was used in the study. The horizontal and vertical response, which are uncoupled due to the symmetry of the structure, were determined for horizontal and vertical excitation. Five different site conditions ranging from competent rock to a soft soil site were considered.

10162 Improved algorithm for non-linear soil amplification. Kausel, E.; Christian, J.T.; Laplante, F.J. (Stone and Webster Engineering Corp., Boston, MA (USA)). pp K1/14 1-9 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The most widely used techniques for the study of one-dimensional amplification of vertically propagating seismic waves involve solution of the dynamic equations in the frequency domain with linearly visoelastic material properties. Material nonlinearities are approximately modeled by iterative use of linear solutions, adjusting values of modulus and damping until they are compatible with computed levels of strain. The program SHAKE is the best know example of a code using this procedure. While the algorithm works well for many cases, it can diverge when a large amplitude of motion is specified at, or near, the surface of a deep stratum of soft soil. The improved algorithm described here starts from the fact that the solution for a given layer below the level of the control motion depends only on the properties of the layer and on the solution for the overlying layers. Divergence can occur in the revised algorithm as it does with the currently used techniques. However, it is controlled to a specific layer, and the solution for the overlying layers have already been obtained before any lack of convergence occurs.

10163 Seismic analysis of a floating nuclear plant. Shulman, J.S.; Orr, R.S. (Offshore Power Systems, Jacksonville, FL (USA)). pp K4/17 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10164 Probabilistic model for seismic analysis of nuclear plant structure. Singh, A.K.; Singh, S. (Sargent and Lundy, Chicago, IL (USA)). pp K3/3 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10165 Seismic analysis of structures by simulation. Sundararajan, C.; Gangadharan, A.C. (Foster Wheeler Corp., Livingston, NJ (USA)). pp K3/2 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper presents a state-of-the-art survey, and recommendations for future work in the area of stochastic seismic analysis by Monte Carlo simulation. First the Monte Carlo simulation procedure is described with special emphasis on a 'unified approach' for the digital generation of anificial earthquake motions. Next, the advantages and disadvantages of the method over the power spectral method are discussed; and finally, an efficient 'Hybrid Monte Carlo-Power Spectral Method' is developed. The Monte Carlo simulation procedure consists of the following tasks: (1) Digital generation of artificial earthquake motions, (2) Response analysis of the structure to a number of sample motions, and (3) Statistical analysis of the structural responses.

10166 Analytical procedure in aseismic design of eccentric structure using response spectrum. Takemori, T.; Kuwabara, Y.; Suwabe, A.; Mitsunobu, S. (Nuclear Project Office, Taisei Corporation, 5-11, 2-Chome, Ginza, Chuo-Ku, Tokyo, Japan). pp K4/7 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

As the design response spectrum enveloping the response spectra derived from the actual earthquake waves generally gives conservative responses, it is utilized as safe and time-saving procedure for the seismic design. In this paper the responses are evaluated by the following two methods by the use of the typical torsional models in which masses, rigidities, eccentricities between the centers thereof and several actual earthquake waves are taken as the parameters; (1) the root mean square of responses by using the response spectra derived from the earthquake waves.(2) the time history analysis by using the earthquake waves. The earthquake waves used are chosen to present the different frequency content and magnitude of the response spectra.

10167 Comparative aseismic response study of different analytical models of nuclear power plant. Takemori, T.; Ogiwara, Y. (Taisei Construction Co. Ltd., Tokyo (Japan)); Kawakatsu, T. (Kansai Electric Power Co., Inc., Osaka (Japan)); Abe, Y.; Kitade, K. (Mitsubishi Atomic Power Industries, Inc., Tokyo (Japan)). pp K2/2 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

As nuclear power plant structures are generally rigid, the influence of rigidities of the foundation rock can be significant in aseismic design of nuclear power plant. This study consists of two major sections; one is comparison of magnification factor of input acceleration between finite model and spring-mass model, the other is evaluation of modified spring-mass models for aseismic design of nuclear power plant. The structure model used in this study is a P.W.R. reactor containment building composed of the outer shield wall, the steel containment and the internal structure.

10168 Simulated earthquake ground motions. Vanmarcke, E.H.; Gasparini, D.A. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Civil Engineering). pp K1/9 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The paper reviews current methods for generating synthetic earthquake ground motions. Emphasis is on the special requirements demanded of procedures to generate motions for use in nuclear power plant seismic response analysis. Specifically, very close agreement is usually sought between the response spectra of the simulated motions and prescribed, smooth design response spectra. The features and capabilities of the computer program SIMQKE, which has been widely used in power plant seismic work are described. Problems and pitfalls associated with the use of synthetic ground motions in sesmic safety assessment are also pointed out.

10169 Measures taken in the member countries of the European Communities for anti-seismic design compared to actual US practice. Vinck, W.; Maurer, H.A. (Commission of the European Communities, Brussels (Belgium)). pp K1/2 1-9 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Most countries of the European Communities base their anti-seismic design parameters on specific US earthquake characteristics. There are, however, important discrepancies in the basic data reported on the two continents as well as in their design application. This was one of the topics under discussion within an European working group on methodologies, criteria and standards in nuclear safety. The contribution is based on an inventory of the applied national practices, the existing specifications, regulations, and guidelines applied in the design, the manufacture, and the safety assessment of structures, systems, and components to withstand potential earthquake consequences in the countries of the European Communities. In a comparison of these national specifications and guidelines the common points of agreement are identified and the divergences discussed with reference to the US practice. Special attention is given to the divergencies for definition and determination of the reference eathquakes. In European countries the definitions of the reference earthquakes are largely analogous to definitions in the US Federal Regulations but expressed in a different way. For European countries, threshold values are proposed to guarantee safety for nuclear power plants.

10170 Effective duration of accelerogram to produce response maxima. Wang, W.Y.L. (Stone and Webster Engineering Corp., New York (USA)). pp K4/5 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10171 Development of ground response spectra from site Mercalli intensities. Werner, S.D.; Ts'ao, H.S. (Agbabian Associates, El Segundo, CA (USA)). pp K1/4 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

10172 Base response arising from free-field motions. Whitley, J.R.; Morgan, J.R.; Hall, W.J.; Newmark, N.M. (Illinois Univ., Urbana (USA). Dept. of Civil Engineering). pp K2/15 1-10 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

A procedure is illustrated in this paper for deriving (estimating) from a free-field record the horizontal base motions of a building, including horizontal rotation and translation. More specifically the goal was to compare results of response calculations based on derived accelerations with the results of calculations based on recorded accelerations. The motions are determined by assuming that an actual recorded ground wave transits a rigid base of a given dimension. Calculations given in the paper were made employing the earthquake acceleration time histories of the Hollywood storage building and the adjacent P.E. lot for the Kern County (1952) and San Fernando (1971) earthquakes.

10173 Finite element method for seismic response analysis. Yu, I.W. (Westinghouse Electric Corp., Pittsburgh, PA (USA). Research and Development Center). pp K3/6 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The purpose of this paper is to present a complete finite element method for the response spectrum analysis of a structural system subjected to a base excitation expressed in terms of both translational and rotational response spectra. The major complexity involved in the procedure is the formulation of the inertial forces associated with a non-inertial frame which is attach to and in motion with the base point of the structure. Throughout the discussion, the rotation of the base point is assumed to be small. The formulation is general and applied to any type of finite element discretization. The inertial forces are formulated on an element by element basis. The mass matrix of the element can be formulated by either the lumped or the consistant mass approach. The procedure on condensation is also utilized to reduce the solution matrix of a large structural

system. The basic principle used in the condensation is to preserve the system kinetic energy, potential energy and the load potential.

ENERGY STORAGE

COMPRESSED GAS

10174 (PNL-SA—7112) **Environmental concerns related to compressed air energy storage.** Stottlemyre, J.A.; Craig, R.A.; Loscutoff, W.V.; Boehm, D.W.; Chang, G.C. (Battelle Pacific Northwest Labs., Richland, WA (USA); Department of Energy, Washington, DC (USA). Div. of Environmental Control Technology; Department of Energy, Washington, DC (USA). Div. of Energy Storage Systems). 1978. Contract EY-76-C-06-1830. 7p. (CONF-780928—3). Dep. NTIS, PC A02/MF A01.

From ANS meeting on environmental aspects of non-conventional energy resources; Denver, CO, USA (26 Sep 1978).

The report describes the technologies of compressed air energy storage and some of the environmental concerns associated with siting, construction, operation and decommissioning of such a system. Also described is an ongoing research program, the goal of which is to evaluate methods to control the effects of these environmental factors.

FLYWHEELS

10175 (COO—4094-63) **Scaling laws for flywheel system components.** Millner, A.R. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 15 Nov 1970. Contract EY-76-C-02-4094. 22p. Dep. NTIS, PC A02/MF A01.

Scaling laws for the major components of a flywheel system for photovoltaic applications are derived from constraining design parameters. Point designs are then calculated for residential and 100-kW load-center energy-storage applications and compared with a subscale prototype unit now being built at MIT Lincoln Laboratory. Results are presented as scaling laws for each component and as tabulated values for each point design. Changes in design are indicated for each component where indicated by effects of scaling. An energy budget is included as an appendix. The results show that rotors and motor-generators scale in much the same way as stress-limited components, while magnetic bearings have a different behavior dominated by magnetic-pressure considerations. For sizes larger than residential, permanent magnets in the bearings and motor-generator should be replaced by electromagnets.

10176 (SAND—79-7089) **Preliminary development of the Band Type Variable Inertia Flywheel (BVIF). Final report.** Ullman, D.G. (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 163p. Dep. NTIS, PC A08/MF A01.

An energy storage flywheel with variable moment of inertia, combining the functions of energy storage and power control is introduced and studied. The specific configuration addressed is the Band Type Variable Inertia Flywheel (BVIF). This hollow shell flywheel is packed with long thin bands of flexible material mounted like the main spring in a watch. The performance equations of this configuration are derived and studied. A proof-of-concept model is described and conclusions are drawn on the BVIF'S operational potential.

10177 (Y—2210) **Oak Ridge Flywheel Evaluation Laboratory. Annual report, April 1, 1979-September 30, 1979.** Steele, R.S. Jr.; Casstevens, J.M.; Sutton, B.J. (Oak Ridge Y-12 Plant, TN (USA)). Dec 1979. Contract W-7405-ENG-48;W-7405-ENG-26. 29p. Dep. NTIS, PC A03/MF A01.

The Oak Ridge Flywheel Evaluation Laboratory (ORFEL) was assembled, and the initial stages of proof testing were completed in FY 1979. The significant accomplishments for the past year included the establishment of adequate full-time personnel; facility modification to reflect the emphasis on flywheel evaluation over simple testing; and the facility proof test involving two aluminum disk flywheels and one composite flywheel. This report contains details of the FY 1979 program plans for ORFEL, personal profiles of the dedicated manpower, and details of the tests performed.

BATTERIES

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 10184, 10185, 10309, 10310

10178 (ANL/OEPM—78-10) **Research, development and demonstration of nickel-zinc batteries for electric vehicle propulsion. Annual report, 1978.** (Energy Research Corp., Danbury, CT (USA)). Oct 1979. Contract W-31-109-ENG-38. 139p. Dep. NTIS, PC A07/MF A01.

This is the first annual report of progress achieved under ANL Contract 31-109-38-4248. It covers the report period from 15 March 1978 to 15 August 1978. The nickel electrode development program is directed at the optimization of the electrical performance, specifically, in terms of increased cycle life. The work concentrated upon both the development of pilot plant facilities to produce nickel hydroxide and upon optimizing the manufacturing processes to produce nickel hydroxide which has high electrochemical utilization. The primary goal of the zinc electrode studies is to increase the cycle life of this electrode. This effort is primarily concentrating on the effect of additives upon shape change and cycle performance and on the mechanistic processes involved in the shape change. The separator effort has as its major goal the development of a low-cost separator which exhibits stability in the electrolyte, has uniform pores which are of a sufficiently small size to impede the growth of zinc dendrites, and exhibits low electrical resistance and good flexibility. The process itself is now optimized for pilot plant manufacture; hundreds of formulations have been produced and subsequently screened in both the laboratory and in actual cells. Promising formulations are presently being subjected to additional characterization tests and life cycles. The goal of the sealed cell studies is to determine the feasibility of sealed-cell operation. Large numbers of 20-Ah cells have been subjected to accelerated testing. These cells incorporated separator variations, active material additives, and internal design variations. Cycle lives up to 150 deep cycles were achieved. Cell failure modes are analyzed. 51 figures, 20 tables.

10179 **Electric battery cell, system and method.** Schwartz, R.E. (to American Energizer Corp.). US Patent 4,154,902. 15 May 1979. Filed date 13 Sep 1976. 16p.

An ambient-temperature electric cell of primary and secondary nature, characterized by the use of the dithionite salt of an active (alkali or an alkaline earth) metal as the charging agent, is described along with processes for manufacturing and for operating it. The dithionite salt is dissolved and suspended in an anhydrous electrolyte comprised of a suitable solvent, which may also contain another salt of the same active metal and may be saturated with sulfur dioxide. To form the cell, a sealed and evacuated enclosure having a negative electrode and a positive current-gathering electrode is filled with the electrolyte and subjected to a charging current sufficient to plate the active metal onto the negative electrode, while the positive electrode is saturated with sulfur dioxide. In the case of a secondary cell, the dithionite produced upon discharge is available as a partially dissolved and suspended salt in the electrolyte. Such availability may be enhanced by a system for forced circulation of the electrolyte. In the case of a primary cell, the final cell potential and discharge characteristics may be enhanced by replacing the dithionite electrolyte with other anhydrous electrolyte solutions (e.g., sulfuryl chloride or thionyl chloride) once the lithium has been plated out. The cell is characterized by extremely low internal resistance, long shelf life, and excellent performance over a wide temperature range. 72 claims.

10180 **Electrochemical cell with calcium anode.** Cooper, J.F.; Hosmer, P.K.; Kelly, B.E. (to Dept. of Energy). US Patent 4,154,903. 15 May 1979. Filed date 17 May 1978. 4p.
PAT-APPL-906,817.

An electrochemical cell comprises a calcium anode and a suitable cathode in an alkaline electrolyte consisting essentially of an aqueous solution of an hydroxide and a chloride. Specifically disclosed is a mechanically rechargeable calcium/air fuel cell with an aqueous NaOH/NaCl electrolyte. 6 claims.

10181 **Water cooled bipolar battery apparatus.** McCartney, J.F.; Shipman, W.H. US Patent . 1 May 1979. Filed date 31 Jul 1978. 9p.

A battery apparatus is provided which includes a plurality of modules which are mounted end-to-end in a stacked pile configuration. Each module contains a plurality of bipolar electrodes. One end of each module has a flexible bladder for storing an electrolyte. The bladders in a collapsed condition provide spacing between the modules for cooling. Each module has a passageway for communicating electrolyte from the bladder to the bipolar electrodes. A device seals each passageway from the respective bladder in one mode of operation and is actuated by pressure on the bladder to open the passageway in another mode of operation. With this arrangement pressure on the bladders will distribute electrolyte into each module and the bladders will collapse to provide a cooling space between the modules.

10182 **Cells having cathodes derived from ammonium-copper-molybdenum-chalcogen compounds.** Jacobson, A.J.; Whittingham, M.S. (to Exxon Research & Engineering Co.). US Patent 4,139,682. 13 Feb 1979. Filed date 30 May 1978. 6p.

The present invention is directed to an electric current-producing cell which contain the following: an anode having as its

anode-active material one or more metals selected from the group consisting of the Periodic Table Group IA metals, Group IB metals, Group IIA metals, and Group IIB metals; a cathode having as its cathode active material one or more compounds selected from either those having the formula $NH_4CuMoZ_{sub\ y}$, where Z is a chalcogen selected from the group consisting of sulfur, selenium, sulfur-selenium mixtures, sulfur-oxygen mixtures, and selenium-oxygen mixtures, and y is a numerical value of about 4, or the decomposition products of one or more compounds listed above, resulting from the decomposition thereof below about 350° C; and an electrolyte that is chemically inert with respect to the anode and the cathode and that permits the migration of ions between the anode and cathode. 27 claims.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 10235

10183 (AD-A—070344) **Computerized pattern recognition applied to Ni-Cd cell lifetime prediction. Interim report.** Byers, W.A.; Perone, S.P. (Purdue Univ., Lafayette, IN (USA). Dept. of Chemistry). Aug 1978. Contract N00014-77-C-0353. 25p. NTIS PC A02/MF A01.

Computerized pattern recognition was used to look for characteristics of new nickel-cadmium spacecraft cells which would be predictive of later performance under stressful conditions. It was found that the changes in voltage while a cell was being charged could be used to make a rough estimate of its lifetime. The standard deviation in the predicted lifetime values was somewhat smaller than the standard deviation of the lifetime distribution as a whole, and there are indications that a more extensive data set would yield better results.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 10179, 10226

10184 Discrete anode bodies for use in various cylindrical cell systems. Urry, L.F. (to Union Carbide Corp.). US Patent 4,154,905. 15 May 1979. Filed date 23 May 1977. 12p.

The invention relates to a cylindrical-type cell employing an outer cathode or cathode collector, a separator, and an inner disposed anode in the form of at least two discrete bodies. The anode bodies have centrally disposed biasing means for continuously exerting an outward force against the anode bodies so as to provide good physical contact between the anode-separator-cathode or cathode collector interfaces. 6 claims.

10185 Cathode or cathode collector arcuate bodies for use in various cell systems. Bubnick, G.F.; Urry, L.F. (to Union Carbide Corp.). US Patent 4,154,906. 15 May 1979. Filed date 23 May 1977. 14p.

The invention relates to a cylindrical type cell employing an outer active metal anode, a separator, and an inner disposed cathode or cathode collector in the form of at least two arcuate bodies. The cathode or cathode collector has outward resilient biasing means for providing continuous physical contact between the anode-separator-cathode or cathode collector interfaces. 5 claims.

10186 Microporous plastic member such as a battery separator and process for making same. Sundberg, E.G.; Campbell, G.A.; Doucette, E.I. (to Aktiebolaget Tudor). US Patent 4,153,760. 8 May 1979. Filed date 15 Oct 1974. 10p.

A process for producing a microporous plastic member useful as a battery separator comprises the following operations: forming a coherent dough by mixing a vinyl chloride resin with a plasticizing amount of a first solvent and with finely divided particles of a filler which contains volatilizable releasable constituent by heating and which shrinks substantially and irreversibly upon release of the volatilizable constituent, an example of which is hydrated silica; forming the solvent-containing dough into a shaped member; extracting the first solvent from the member before any substantial evaporation of solvent occurs by contacting it with a second solvent in a liquid bath at a temperature substantially below the boiling point of any liquid present, the second solvent being one which is capable of dissolving the first solvent without dissolving the resin and the filler, thereby deplasticizing the member by extractively removing the first solvent from the member; and thereafter heating the member at an elevated temperature but below the softening point of the resin until the filler is shrunk within the member by release of its volatilizable content. 10 claims.

10187 Stabilization of $LiAsF_6$/dimethyl sulfite electrolyte solution. Horning, R.J.; Ebner, W.B. US Patent 4,107,404. 15 Aug 1978. Filed date 15 Sep 1977. 2p.

$LiAsF_6$/dimethyl sulfite electrolyte solutions of improved storage stability are obtained by incorporating metallic lithium therein.

APPLICATIONS

REFER ALSO TO CITATION(S) 9894, 10235

ENERGY MANAGEMENT AND POLICY

REFER ALSO TO CITATION(S) 10239

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 9666, 9855, 10266

10188 (ANL/EES-TM—71) **Overview of RELCOMP, the reliability and cost model for electrical generation planning.** Buehring, W.A.; Hub, K.A.; VanKuiken, J.C. (Argonne National Lab., IL (USA)). Nov 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

RELCOMP is a system-planning tool that can be used to assess the reliability and economic performance of alternative expansion patterns of electric-utility-generating systems. Given input information such as capacity, forced outage rate, number of weeks of annual scheduled maintenance, and economic data for individual units along with the expected utility load characteristics, the nonoptimizing model calculates a system maintenance schedule, the loss-of-load probability, unserved demand for energy, mean time between system failures to meet the load, required reserve to meet a specified system-failure rate, expected energy generation from each unit, and system energy cost. Emergency interties and firm purchases can be included in the analysis. The calculation can be broken down into five distinct categories: maintenance scheduling, system reliability, capacity requirement, energy allocation, and energy cost. This brief description of the program is intended to serve as preliminary documentation for RELCOMP until a more-complete documentation is prepared. In addition to this documentation, a sample problem and a detailed input description are available from the authors.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 9646, 9649, 9666, 9839, 9840, 10198, 10203, 10254, 10266, 10598, 10599, 10602

10189 (PB—292804) **California Innovation Group, final reports; technical report volume.** (California Innovation Group, Inc., San Jose (USA)). Apr 1978. 120p. NTIS PC A06/MF A01.

The document consists of technical reports resulting from the research plan of the California Innovation Group (CIG). It presents a summary of the plan and a statement of status of the CIG followed by a detailed statement of work and project accomplishments. A general process in effecting technology transfer is outlined: the development of technology-based solutions to problems and needs identified by local government, performance of proof-of-concept experiments to verify resolution, the transfer of packages to other cities, and evaluation of their effectiveness. The research is structured into technology analysis, utilization analysis, special projects, and information network. Milestone charts showing planned vs. actual performance for individual activities appear in the first section. Some topics of research are alternative futures for CIG, urban needs, productivity and effectiveness, a comparison of compact vs. full size police vehicles, and science advisors' reports on the California cities of Burbank and Pasadena.

10190 (PB—292999) **Politics of energy: Astoria No. 6, a case study of energy-environmental cleavages within New York City. Working paper.** Aron, J.; Sheinbaum, E. (New York Regional Energy Study, NY (USA)). Sep 1974. 75p. NTIS PC A04/MF A01.

The possible impact of areawide residential location policy on future residential electricity usage in the Tri-State Metropolitan Region centering on New York City is investigated. This report focuses on the politics of energy in its discussion of Con Edison's attempt to expand the generating capacity of its Astoria Plant in Queens in 1969. Examined in detail are the orientation and strategies employed by the major public and private participants: Con Edison, New York City--the Mayor, Environmental Protection Administration, Interdepartmental Committee on Public Utilities, Economic Development Administration, elected officials, and interest groups. Major characteristics of the decision-making process illuminated by the Astoria controversy are summarized.

10191 Selection of discount rates in energy cost analysis using discounted-cash-flow (DCF) and revenue-requirement (RR) methodologies. Phung, D.L. (Inst. for Energy Analysis, Oak Ridge, TN).

Contract EY-766-05-0033. *Energy Syst. Policy;* 3: No. 2, 145-170(1979).

The discounted cash flow (DCF) and revenue requirement (RR) methods are commonly used to analyze the cost of energy technologies. This paper shows that they are rigorously equivalent. The significance of and relationship between several rates of discount are explored under both noninflationary and inflationary economic conditions. For comparing energy costs between alternative future technologies, the RR method is almost universally used even though the DCF method is often claimed. Three rates of discount are studied. These are the before-tax discount rate; the nominal after-tax discount rate; and the effective, tax-adjusted discount rate. It is shown that any of these rates can be used in cost analysis, provided the right cash flow streams are considered. A general formula is developed that permits the calculation of unit energy cost on the basis of known and simple cost information. The general formulation for the DCF and RR methods is valid under both constant-dollar and inflationary conditions. It is also shown that a pricing policy can be designed to reflect noneconomic purposes and still satisfy financial requirements. Three pricing policies are explored: level price, inflation-adjusted price, and cost-of-money adjusted price. 16 references.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 10200, 10215, 10249, 10595, 10597

10192 (NTIS/PS—79/0846) **Energy conservation: Policies, programs, and general studies (A bibliography with abstracts). Report for 1964-June 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 291p. NTIS PC N01/MF N01.

Abstracts pertaining to national policies, programs, and general studies of ways to conserve energy are presented. Topic areas cover such subjects as electric load management, effects of price and taxation on energy conservation, public attitudes and behavior toward energy saving, energy savings through reduction in hot water consumption, and telecommunications substitutability for travel. (This updated bibliography contains 285 abstracts, 70 of which are new entries to the previous edition.)

10193 (PB—292753) **The timely development of environmental, safety, and health standards for energy technologies.** Steiner, B.W. (National Bureau of Standards, Washington, DC (USA)). Jan 1979. 41p. NTIS PC A03/MF A01.

The Division of Operational and Environmental Safety (OES) was established in the spring of 1977 as a division of the former Energy Research and Development Administration. As one of its first tasks, OES commissioned the National Bureau of Standards to develop a comprehensive plan for the development of nonnuclear energy-related environmental, safety, and health standards for the Department of Energy. The objective was to provide assurance that the exploitation of new energy technologies by the private sector would not be hindered by the absence in the private sector of (1) all necessary environmental, safety, and health standards; or (2) the ability to comply with them. A detailed plan was submitted to the Division in September 1977. During the preparation of that report it became clear that the effort commissioned by the OES was representative of a broad transformation with great significance for the standards development process in the United States. The present report consists of a paper describing that transformation in the role of standards, its significance, and the broad implications.

10194 **Environmental assessment: approaching maturity.** Bendix, S.; Graham, H.R. Ann Arbor, MI; Ann Arbor Science (1978). 288p. (CONF-770266—).

From Conference on environmental assessment; Washington, DC, USA (9 Feb 1977).

Environmental professionals realistically evaluate the implementation of environmental policy over the past six years. Papers deal with concrete experience, not abstract ideals. Five major sessions dealt with: information requirements for decisionmaking; commonality and diversity of State and Federal regulations; public responsibilities; the review process; and what lessons have been learned. The last session was approached from the four perspectives of administrative, technical, private and public decision making. (PCS)

NATURAL RESOURCES

REFER ALSO TO CITATION(S) 10594

10195 (PB—292856) **Teaching conservation in developing nations.** Brace, J.; White, R.R.; Bass, S.C. (ACTION/Peace Corps, Washington, DC (USA)). 1977. 262p. NTIS PC A12/MF A01.

The goal of conservation education is to lead the public through a series of steps about nature, land, and natural resources which include: awareness, understanding, respect, responsibility, and action. This manual provides ideas, activities, and resources for incorporating conservation education into day-to-day community activities. It is structured around a local center which can be used to present an on-going conservation education program by means of pictures and posters, exhibits and collections, films and discussions.

RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION

REFER ALSO TO CITATION(S) 9621, 9625, 9627, 9628

10196 (AD-A—070500) **Energy conversion. Report bibliography April 1962-November 1978.** (Defense Documentation Center, Alexandria, VA (USA)). Jun 1979. 309p. NTIS PC A14/MF A01.

This bibliography contains unclassified and unlimited citations of reports giving a review of research and development pertaining to energy conversion. Four computer-generated indexes are provided: Corporate Author-Monitoring Agency, Subject, Title and Personal Author.

10197 (DOE/CR—0010) **U.S. Department of Energy project book.** (Department of Energy, Washington, DC (USA)). Jan 1980. 86p. Dep. NTIS, PC A05/MF A01.

This book covers representative projects in each program within the Department of Energy. The projects included were selected to provide an insight into the wide spectrum of projects authorized and under way in the Department. The projects described do not cover all projects authorized - they are merely representative. Descriptions, goals, and status are given for 29 energy projects, 4 scientific projects, and 5 defense projects. (RWR)

10198 (PB—292882) **SEMTAP: a new technology transfer network to link business and industry with federal research and development. Final report Oct 76—Nov 78.** (Environmental Research Inst. of Michigan, Ann Arbor (USA)). Mar 1979. 50p. NTIS PC A03/MF A01.

The technical assistance study under the Southeastern Michigan Technical Assistance Program (SEMTAP) was established consisting of the Environmental Research Institute of Michigan working with ten community colleges in Southeastern Michigan. The system was intended to demonstrate the effectiveness of providing extensive services directly to local organizations on a wide range of domestic problems which can benefit from information developed by federally-sponsored research and development. A major objective of the SEMTAP program was to assist business expansion and create new job opportunities in Michigan.

10199 **Incentives for converting industrial plants to new fuels.** Passman, R.A.; Allen, M. (Dept. of Energy, Washington, DC). pp 669-678 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

To summarize, I have reviewed the process by which DOE determined which emerging technologies are ready for commercialization. I have also discussed other barriers to commercial initiation and subsequent use. We reviewed incentives generally for their role in stimulating the market in order to accelerate the commercialization of the coal-derived fuels. I described a sample venture analysis showing how interrelations between market and economics with varying incentives could be evaluated for private industry decisions, and for determining the public benefit of achieving the energy output for a reasonable expenditure of public funds.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 10151

10200 **Legal advocacy and nuclear power: the impact of litigation on the Midland nuclear plant.** Cook, C.E. Boston, MA; Boston Univ. (1979). 264p. University Microfilms Order No. 79-23,922.

Thesis (Ph. D.).

The use of litigation as an interest-group strategy is analyzed in relation to the controversy over the development of nuclear power. An assessment is made of the impact of the judicial process, with the litigation involving the Midland, Michigan, nuclear plant serving as a representative case study. In the construction permit

hearings for the Midland nuclear plant, which began in 1970, the interest groups were Consumers Power Company, a Michigan utility, and the Saginaw and Mapleton Intervernors, environmentalists dwelling near the proposed plant site. The Nuclear Regulatory Commission issued a construction permit for the plant after a two-year licensing process, but the environmental groups appealed the permit to the United States Court of Appeals for the District of Columbia Circuit. In 1976, the permit was remanded by the court to the Commission for reconsideration, and Consumers Power Company appealed that decision. In 1978, the Supreme Court handed down a unanimous and definitive opinion, Consumers Power Company vs Aeschliman, that upheld the Commission's original issuance of the construction plant. The Midland case well illustrates the detrimental impact that legal advocacy has had on atomic energy by prolonging the regulatory process. The positive consequences of the Court ruling favoring the utility's position were outweighed by the expense involved in the initial ten years of thelicensing and subsequent lawsuits concerning the Midland plant. Consequently, Consumers Power Company is representative of most other American electric companies in its determination that it cannot build additional nuclear plants without mitigation of the uncertainty and duration of the regulatory process. Thus, it may be concluded that the environmental groups' use of legal advocacy at Midland and elsewhere has proven to be an effective strategy for undermining the nuclear industry and for deterring the future development of nuclear power.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 10297

CONSERVATION

REFER ALSO TO CITATION(S) 9786, 10203, 10240, 10242, 10245, 10246, 10247, 10249, 10256, 10257, 10258, 10259, 10260, 10266, 10289, 10293

10201 Energy and nitrogen fixation. Gutschick, V.P. (Los Alamos Scientific Lab., NM). *Bioscience;* **28**: No. 9, 571-575(Sep 1978).

The energy consumed by the fixation of N_2 by plants and by industrial processes is determined. Alternatives for reducing energy consumption are examined and future options reviewed. The author recommends improved management of soil nitrogen and research to overcome the genetic limitations of plants in fixing nitrogen. (ACR)

10202 (UCRL—15120) **Potential for energy conservation: St. Louis Case Study.** Levine, M.D.; Whittier, J.P. (SRI International, Menlo Park, CA (USA)). Aug 1979. Contract W-7405-ENG-48. 69p. Dep. NTIS, PC A04/MF A01.

The method of approach to study energy conservation potential in St. Louis is described. It is observed that the key features of St. Louis are: uncertainty of population and economic projections; growth of suburban areas and decline of the inner city during the past two decades; inner city has numerous social/economic problems; inadequate (economically suboptimal) levels of energy conservation in existing buildings and in new construction; limited public transportation within SMSA; high level of complexity in the governmental organizations; lack of sophistication in energy planning particularly in the public sector; and small and not very influential environmental/energy conservation public interest groups. Specific areas chosen to study the technical and economic potential for energy conservation in the St. Louis SMSA are space heating and appliance energy use. An Appendix, Institutions in St. Louis: Their Influence on Energy Planning, lists the following: local energy decisionmakers, existing energy conservation programs (all sectors), and existing renewable resource programs. (MCW)

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 9640, 9645

10203 (DOE/PE—4706) **Energy self-sufficiency in Northampton, Massachusetts.** (Hampshire Coll., Amherst, MA (USA)). Oct 1979. Contract EJ-78-X-01-4706. 281p. Dep. NTIS, PC A13/MF A01.

The study is not an engineering analysis but begins the process of exploring the potential for conservation and local renewable-resource development in a specific community, Northampton, Massachusetts, with the social, institutional, and environmental factors in that community taken into account. Section I is an extensive executive summary of the full study, and Section II is a detailed examination of the potential for increased local energy self-sufficiency in Northampton, including current and future demand estimates, the possible role of conservation and renewable resources, and a discussion of the economic and social implications of alternative energy systems. (MOW)

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 10151, 10200, 10211, 10214, 10249

FOSSIL FUELS

REFER ALSO TO CITATION(S) 10238

COAL

REFER ALSO TO CITATION(S) 9581, 9621, 9622, 9623, 9624, 9625, 9626, 9627, 9628, 9629

PETROLEUM

REFER ALSO TO CITATION(S) 9629, 9632, 9634, 9638, 9639, 9640, 9641, 9645, 9646, 9649, 10602

NATURAL GAS

REFER ALSO TO CITATION(S) 9632, 9638, 9665, 9666, 9667, 10602

HYDROGEN AND SYNTHETIC FUELS

REFER ALSO TO CITATION(S) 9576

ELECTRIC POWER

REFER ALSO TO CITATION(S) 10188

10204 (DOE/ERA—6385) **Florida Electric Power Coordinating Group: an evolving power pool.** (Resource Planning Associates, Inc., Cambridge, MA (USA)). Oct 1979. Contract EB-78-C-01-6385. 51p. Dep. NTIS, PC A04/MF A01.

The FCG is an informal power pool representing 6 investor-owned utilities, 18 municipal utilities, and 13 rural electric cooperatives. Collectively, these systems represent roughly 99% of the electric generation and transmission capacity in Florida. The organization of the FCG, particularly the activities of the Operating and System Planning committees is discussed. The chronological development of the FCG is outlined and its evolution through the various stages of coordination and interconnection are described.

10205 (DOE/ERA/6359—2) **Synthesis of Regional Electric Reliability Council responses to the recommendations issued by the Federal Power Commission following the 1977 New York City blackout.** Corwin, J.L.; Miles, W.T.; Walldorf, S.P. (Systems Control, Inc., Palo Alto, CA (USA)). Dec 1979. Contract EB-78-C-01-6359. 113p. Dep. NTIS, PC A06/MF A01.

A synthesis of Regional Electric Reliability Council responses to the recommendations issued by the FPC following the 1977 New York City blackout is presented. The report also presents recommendations to DOE and utilities based on these responses, and in the context of ongoing Federal, state, and utility activities to assess the adequacy and reliability of utility bulk power supplies, and its worth to the customer. The eleven recommendations are grouped in areas covering system planning and design or operations. Six are covered under system planning and design: generation and transmission (3); reserve criteria (1); protection and control (1); and auxiliary power (1). Five are covered under system operations: normal and emergency procedures/coordination (2); personnel training (1); load shedding (1); and restoration (1). The study focuses on the Consolidated Edison system but may be applicable to all other utilities because of electric system design and operation similarities. (MCW)

10206 (NP—22578(Vol.1)) **Electric Utility Rate Design Study: rate design study - load research.** (Gilbert Associates, Inc., Reading, PA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 1 Nov 1979. 224p. EPRI, Palo Alto, CA.

An investigation and its findings are reported relating to the Load Research portion of Topic I of the Electric Utility Rate Design Study, 1978 Plan of Study, December 21, 1977. This report summarizes the efforts to meet four broad objectives: (1) obtain as much information as possible regarding past, present, and future load-research tests which provide data regarding the time of use of electrical energy useful in time-differentiated energy and demand

analyses and in the design of time-of-day rate schedules; this includes load research of residential, rural, farm, commercial, industrial, and municipal classes of service, and load research of individual appliances and equipment; (2) obtain as much information as possible regarding the load-research aspects of past, present, and future time-of-day rate experiments including base rate schedules for the control customers and experimental rate schedules for the test customers; (3) review, analyze, and catalog the information stated above in an appropriate manner; and (4) recommend guidelines for future load research so that data obtained will be more usable by ratemakers, system planners and financial analysts.

10207 (NP—22578(Vol.2)) **Electric Utility Rate Design Study: rate design study - load research.** (Gilbert Associates, Inc., Reading, PA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 1 Nov 1979. 242p. EPRI, Palo Alto, CA.

This report, Vol. II, contains appendices on the information reported relating to the Load Research portion of Topic I of the Electric Utility Rate Design Study, 1978 Plan of Study, December 21, 1977. These include: abstracts of load research reports received with the questionnaires; abstracts of time-of-day tests and experiments for which reports were provided by the utilities; condensed statements of rates supplied for the reported and/or abstracted time-of-day tests and experiments; Association of Edison Illuminating Companies, load research committee's cumulative index of subjects, load research committee reports, 1959 to 1974; example of AEIC load research committee's reporting format; selected pages from the National Bureau of Standards report NBS GCR 78-130, an annotated compilation of the sources of information related to the uses of electricity in non-industrial applications, Ben Reznek, Consultant, July 1978; example of reply to questionnaire used by EPRI Task Force 3; consultant's suggested parameters for selecting lateral or feeder circuits for load research testing, by Gilbert Associates, Inc.; Ontario hydro - load analysis report abstracts; and historical development of load research hardware.

10208 (NP—24247) **Electric Utility Rate Design Study: an evaluation of reconciliation procedures for the design of marginal cost-based time-of-use rates.** (Gordian Associates, Inc., New York (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 7 Nov 1979. 134p. EPRI, Palo Alto, CA.

A number of methods that have already been proposed for reconciling the difference between revenues with rates set at marginal costs and those revenues that would result from the prescribed accounting procedures is addressed. Two distinct but related reconciliation problems are addressed. The first relates to how the overall revenue difference is spread across customer classes while the second relates to how marginal costs are used to design rates which match the revenue target for each class. (MCW)

10209 (NP—24254(Vol.1)) **Electric Utility Rate Design Study: rate design study - load research.** (Gilbert Associates, Inc., Reading, PA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 1 Nov 1979. 154p. EPRI, Palo Alto, CA.

Gilbert Associates' Rate Design Study: Load Research catalogs present load research studies by means of a literature search and a comprehensive survey of electric utilities in the United States and Canada. Additionally, twenty-three utilities recognized for their load research experience are surveyed to further identify computer capabilities and data accessibility related to load-research programs. Guidelines for future load-research efforts are developed. This investigation is not to be considered as a bibliography of load research tests and time-of-day rate experiments. The major findings and conclusions are presented.

10210 (NP—24254(Vol.2)) **Electric Utility Rate Design Study: rate design study - load research.** (Gilbert Associates, Inc., Reading, PA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 1 Nov 1979. 243p. EPRI, Palo Alto, CA.

Volume I of Rate Design Study: Load Research catalogued present load research studies by means of a literature search and a comprehensive survey of electric utilities in the US and Canada. This volume, Vol. II, presents the appendices to Volume I, containing detailed information from 20 utilities provided for the load-research study. (MCW)

10211 (NP—24259) **Electric Utility Rate Design Study: reference manual and procedures for implementing PURPA.** (Electric Power Research Inst., Palo Alto, CA (USA)). Mar 1979. 198p. EPRI, Palo Alto, CA.

State regulatory commissions will be assisted by using this manual in carrying out their responsibilities under the National Energy Act, specifically under the Public Utilities Regulatory Policies Act (PURPA). The research and materials of the Rate Design Study are basically applicable to Title I of PURPA, and the Manual covers only that part of the Act. The Rate Design Study covers a wide scope of research and professional opinions and are a major reference source for data, information, and divergent views on practically every aspect of electric utility rate design. The introductory part calls attention to particularly important aspects of responsibilities, authority, and procedures. The second part outlines the specific responsibilities placed by Title I of PURPA on the State commissions. Part 3 discusses some of the procedural and substantive requirements and options of PURPA with particular emphasis on their relation to the Rate Design Study, State law, and State regulatory policies. Part 4 is an independent analysis that includes cross-indexed references to the more than 60 reports prepared by the Rate Design Study and also to other pertinent sources of information and data. Part 5 summarizes a survey conducted in January 1979 of State commission actions related to the matters contained in Title I of PURPA. Part 6 presents the text of the law. Part 7 is the request from NARUC that prompted the preparation of the Manual. (MCW)

10212 (NP—24260) **Electric Utility Rate Design Study: equipment for load management - communications, metering, and equipment for using off-peak energy, topic 4.** Schaefer, J.C. (Electric Power Research Inst., Palo Alto, CA (USA)). Oct 1979. 157p. EPRI, Palo Alto, CA.

Information provided contributes to the needs of regulators and utilities by providing insights and information on: the availability of suitable equipment and its engineering limitations to establish technologically feasible load-management strategies; the modes of operation of load control and end-use equipment affecting whether customers will accept the equipment; the metering capability limiting the rate structures that are possible; the mode of equipment operation and experimental results as important inputs to the projection of load shapes; and cost data for implementing load-management strategies necessary for the determination of cost-effectiveness. Information is compiled on three major categories of equipment: communications and load control; end-use equipment; and metering for time-of-use rates. Attention is directed mainly at residential customers, but much of the equipment described can be applied to commercial and industrial customers. (MCW)

10213 (NP—24261) **Electric Utility Rate Design Study: the problem of the second best and the efficient pricing of electrical power.** (Gordian Associates, Inc., New York (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 7 Aug 1979. 101p. EPRI, Palo Alto, CA.

An analysis of the implications of the economic theory of the second best for the pricing of electrical power is presented. Usefulness of adjusting marginal-cost prices of electricity to take into account deviations from marginal costs of prices elsewhere in the economy is evaluated. The theory of the second best, as originally presented, is a proposition about the efficiency of the economy when some products are not priced at marginal costs. In such a case, there may be gains to be made by enacting corresponding deviations of price from marginal cost in other products. This study analyzes the implications of this hypothesis for the pricing of electricity. The study sought to discover whether such adjustments to marginal-cost prices were justified for electricity and, if so, how they would be calculated. Results show that, in order for one to be certain that the calculated second-best adjustments improve efficiency in the economy, prices, marginal costs, and demand functions for all other goods and services must be taken into account. What is more, second-best adjustments cannot be calculated for any particular utility in one regulatory jurisdiction alone. Instead, these adjustments must be calculated for all jurisdictions simultaneously. Without such detailed, fully-coordinated action, it is not possible even to say whether second-best adjustments should increase or decrease marginal-cost prices. Therefore, it would seem that the next best thing is to ignore second-best elements in pricing policy in local regulatory jurisdictions.

10214 (NP—24263) **Electric Utility Rate Design Study: electric-utility rate-design and load-management activities - 1979 survey of State and Federal Regulatory Commissions.** Kuenstler, D.A. (Elrick and Lavidge, Inc., San Francisco, CA (USA); Electric Power Research Inst., Palo Alto, CA (USA)). 7 Jun 1979. 761p. EPRI, Palo Alto, CA.

Included in this report is a copy of the questionnaire mailed on January 12, 1979 to the Chairmen of the 50 state regulatory commissions plus the District of Columbia and Puerto Rico. Follow-up telephone calls were made to all nonresponding commissions on January 22 and 29. This report summarizes the 46 responses (45 States plus the District of Columbia) received by March 1. A blank copy of the questionnaire and copies of all completed questionnaires are provided.

10215 **Financial impacts of proposed new source performance standards on the electric utility industry.** Ford, A. (Los Alamos Scientific Lab., NM); Baughman, M.L.; Cooper, H.B.H. Jr.; Kamat, D.P. *Energy Syst. Policy;* 3: No. 2, 113-144(1979).

This paper describes the results of an analysis of the probable impacts of proposed New Source Performance Standards on the US electric utility industry. Proposed standards for sulfur oxides, particulates, and nitrogen oxides are described according to the additional costs imposed on the electric utility industry. The financial effects of

the additional cost burden are calculated using a regional simulation model of the electric utility industry. A range of assumptions concerning proposed standards and the regulatory-financial climate are considered. It is concluded that the financial health of the industry is much more dependent on the rate-setting practices of state regulatory commissions than on whether or not an additional cost of $50 to 100/kW for pollution control is required for coal-burning power plants.

ELECTRIC POWER GENERATION

REFER ALSO TO CITATION(S) 9778, 10035

10216 Quantitative comparison of energy-costing methods. El-Sawy, A.; Leigh, J.G.; Trehan, R.K. (MITRE Corp. , McLean, VA). Contract EG-77-C-01-4014. *Energy Syst. Policy;* 3: No. 2, 213-226(1979).

This paper presents a review and analysis of methodologies used for estimating electricity-generation costs, with particular reference to geothermal energy, although the main conclusions apply equally to other sources of electricity. The costs projected by the different methods for two test cases are presented, and estimates are made of the sensitivity of the results to critical methodological choices.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

10217 (PB—292589) **A study of the costs of alternative communication systems for utility distribution automation. Final report.** Howard, M.F. (Systems Control, Inc., Arlington, VA (USA)). Feb 1979. Contract FCC-0244. 143p. NTIS PC A07/MF A01.

Communication requirements for load management and automated operation of electric utility distribution lines are determined, feasible communication systems are identified, and cost of systems are estimated. Radio, telephone, power line carrier, and CATV are considered.

CONSUMPTION AND UTILIZATION

REFER ALSO TO CITATION(S) 9649, 10241, 10242, 10254, 10256, 10257, 10258, 10259, 10260, 10289

UNCONVENTIONAL SOURCES AND POWER GENERATION

REFER ALSO TO CITATION(S) 10203

SOLAR

REFER ALSO TO CITATION(S) 9780, 9786, 9787, 9807, 9904, 9905, 9940, 9941, 9942, 9943, 9944, 9945, 9946, 9947, 9948, 9949, 9950, 9951, 9952, 9953, 9954, 9955, 9977, 9978, 9979, 10247

GEOTHERMAL

REFER ALSO TO CITATION(S) 10007, 10216

OTHER

REFER ALSO TO CITATION(S) 9653, 9747, 9770, 9839, 9840, 9841, 9842, 9855, 10598, 10599, 10600

ENERGY CONVERSION

10218 Method and apparatus for generating electricity. Clark, W.T. III. US Patent 4,153,757. 8 May 1979. Filed date 20 Sep 1977. 6p.

Two spaced electrodes having a load in an external circuit connected between them are disposed in an electrically conductive liquid, and energy is imparted to the liquid in such manner that energized free electrons in the liquid excite free electrons which flow into one electrode to a greater degree than in the other electrode, thereby causing electric current to flow in the external circuit through the load.

MHD GENERATORS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 10223

10219 (DOE/ET/2895—5) **MHD high performance demonstration experiment. Quarterly progress report, April 1, 1979-June 30, 1979.** (Arnold Engineering Development Center, Arnold Air Force Station, TN (USA)). Jul 1979. Contract ET-78-I-01-2895. 33p. PC 03/MF A01.

The objective of this experimental research, started late in 1973, is to demonstrate the attainment of MHD performance ona sufficiently large scale to verify that the projected efficiency of the commercial MHD concept is attainable. To perform the experiment, an existing facility at the Arnold Engineering Development Center (USAF) was refurbished and the new systems required for performing the experiment have been designed and built. In particular, the largest systems which have required the greatest expenditure of resources are the generator channel and the 6 Tesla (T) cryogenically cooled magnet. Both of these systems are now complete and the magnet has been tested at low field strengths. During the period between April 1, 1979, and June 30, 1979, the assembly operations on the magnet and its cryogenic cooling system were completed. The pressure testing of the generator channel was completed and the channel was installed in the magnet to facilitate final alignment of the burner. The diffuser assembly operations were completed. The magnet was retested in the warm mode, repeating the tests performed in December 1978 during wich an arc-over occurred. No problems were encountered in the latest tests and the magnet was subsequently cooled to 165°K and pulsed to a peak field strength of 2.9 T. Analytic studies of the operation of the generator with supersonic flow at low magnetic fields were started and are continuing.

10220 Flowing saline water magnetohydrodynamic electric generator. Hendel, F.J. US Patent 4,151,423. 24 Apr 1979. Filed date 27 Jun 1978. 8p.

A magnetohydrodynamic electric generator is described for the direct energy conversion of the kinetic energy of saline water flowing through a magnetic field, preferably in the constricted part of a duct. Means may be provided to increase the kinetic energy of the flowing saline water using wave-powered air compressors and/or water pumps. Also described are sea platforms containing a multitude of electricity generators in a configuration to maximize the conversion of the kinetic energy of flowing saline water into electric energy. 23 claims.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 10219

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 10219

10221 (CONS—3005-T2) **MHD air heater development technology. Report for the period October 1978-December 1978.** (FluiDyne Engineering Corp., Minneapolis, MN (USA)). Apr 1979. Contract ET-78-C-01-3005. 25p. Dep. NTIS, PC A02/MF A01.

During the period covered by this report, work was done on all three tasks and is summarized as follows: Under Task 1 (design studies) the influence of heater system layout, duct dimensions, and heater sequencing on flow distribution was studied further. One result was that localizing the bulk of the pressure drop in the heaters tends to minimize heater-to-heater flow differences. The task of integrating the temperature and pressure solvers was pursued further. An analysis of current flow back up the air duct from the combustor was done. Results showed that the voltage gradient and power loss back up the air duct depend on the ratio of electrical conductivities of air and duct wall insulation. Under Task 2 (design support tests) Heat 201 was completed and much of the construction on the valve test rig was completed. Heat 201 was run with a Corhart X-317 (fusion cast magnesia-35% alumina, hereafter referred to as Corhart X-317 as this trade name designates not only composition, but microstructure, impurity level and manufacturer's process) matrix in the rig. Matrix Test 7 (Heat 201) ran for over four hundred hours but was terminated early because of a restriction in the bed. This was caused by failure of the insulating lining in the hot gas duct between the burner and the matrix. This liner of magnesia-chrome bricks (RFG) had been used in earlier tests. Reactions with seed/slag occurred and the resulting high viscosity slag partially plugged the bed. Under Task 3 (preliminary design of 5 MW heater) a topical report describing the design of the 5 MW test heater system was prepared. At the end of this reporting period it was being reviewed.

10222 (CONS—3005-T4) **MHD air heater development technology. Report for the period July, 1978-September, 1978.** (FluiDyne Engineering Corp., Minneapolis, MN (USA)). Jan 1979. Contract ET-78-C-01-3005. 76p. Dep. NTIS, PC A05/MF A01.

The statement of work divides the effort into three tasks: Task 1 (design studies): The objectives of this task are to: (1) evaluate full-scale, direct- and indirect-fired regenerative air heater systems from use in MHD power plants; (2) support testing of refractory materials, hot gas valves, and design concepts; (3) support design of a 5 MW test heater. Task 2 (design support tests): The objectives of this task are to: (1) support design of a 5 MW test heater; (2) identify and evaluate life of promising refractory materials for use in MHD heaters; (3) determine operating conditions and bed geometry (hole size, web thickness which permit operation without clogging of heater passages due to accumulations of seed/slag or slag alone, (4) test valves for use in hot gas streams which are laden with seed/slag or slag alone. Task 3 (vertical slice test bed): The ojbective of this task is to provide a preliminary design of a test heater which is a vertical slice of a full-sclae heater. It will be sized for a thermal input of ~ 5 MW. Testing with hot gas streams containing seed/slag or slag alone will be accommodated in order to simulate both direct-and indirect-diring. Progress is reported in detail on these tasks.

10223 (FE—2246-8) **Testing and evaluation of MHD materials and substructures. Annual technical progress report, July 1977-June 1978.** Murphree, D.L.; Bell, C.J.; Cain, R.W.; Coleman, H.W.; Malloy, T.B.; Nail, J.B.; Powe, R.E.; Shepard, W.S.; Wehr, A.G. (Mississippi State Univ., Mississippi State (USA). Energy Research Center). Jul 1978. Contract EX-76-C-01-2246. 188p. Dep. NTIS, PC A09/MF A01.

Mississippi State University's MHD research group has constructed a Test Stand that can simulate the environment in any of the various substructures of the coal-fired baseline MHD power plant. The Test Stand has been successfully operated under total computer control with air heating and oil combustion. A series of short-term shakedown tests have been performed, and the Test Stand is now being operated, with slag injection, for longer durations of time in order to deposit the slag throughout the system and especially on the annular boiler walls, and to also eliminate any bugs in the systems that would cause a shutdown during long-term operation. A computer-based system has been developed that provides safe Test Stand operation, controls the critical parameters, and accurately measures, displays and logs the necessary physical data. Several thermal models have been developed in order to predict the thermal performance of the Test Stand and the boiler test sections. Work is almost finished on the final design of the radiant boiler simulation system which will include a radiant boiler test section and the necessary auxiliary components to produce steam at the proper temperature and pressure for simulation of the water-side thermal conditions and boiler tube metal temperatures. A gas sampling analysis system has been designed and is being constructed to analyze the gas stream at various locations along the length of the Test Stand. Intrusive probes will be used to conduct preliminary screening tests on candidate boiler tube materials during the annualr boiler test runs. Fault-tolerance analyses have been performed on the control and shutdown systems. A comprehensive safety study has been conducted, and the results are reported along with an operations manual for the MHD system.

10224 **New developments in coal-fired combustors for magnetohydrodynamics.** Wright, R.J. (Pittsburgh Energy Technology Center, PA). pp 515-529 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

Major accomplishments in magnetohydrodynamic component development in generators, superconducting magnets, air heaters, and in the control of SO_3 and NO/sub x/, have occurred during the last several years. Attention is now focusing on the development of other components in the magnetohydrodynamics power train, such as coal-fired combustors, on larger scale components, and on facilities in which to develop and integrate the large scale components. Coal-fired combustor projects being conducted under the auspices of the US Department of Energy include a 20 MW(t), single-stage, plug flow, high-ash carryover combustor by the University of Tennessee Space Institute, a 5 MW(t), two-stage, low-ash carryover combustor by the Pittsburgh Energy Technology Center, and a competitive, industrial development effort leading to a 50 MW(t) combustor for the Component Development and Integration Facility in Butte, Montana, involving Avco Everett Research Laboratory, Inc., TRW, and Rockwell. This comprehensive and coordinated program is expected to establish a technology data base for coal-fired combustors that will be used to design combustors for demonstration of the magnetohydrodynamics power cycle at the 300 MW(t) plant size.

10225 **Ceramic component for electrodes.** Marchant, D.D.; Bates, J.L. (to Dept. of Energy). US Patent Application 961,152. 16 Nov 1978. 10p.

A new ceramic material for MHD generator electrodes has been prepared based upon yttrium chromite which has adequate electrical conductivity for MHD electrode application, which is less subject to volatilization and hydration problems of the analogous lanthanum chromite materials which have a low electrochemical corrosion rate. The new material consists in the use of magnesium as a dopant and in the replacement of some or all of the chromium with aluminum. According to the present invention a ceramic component for MHD generator electrodes has the compositional formula: Y/sub x/(Mg/sub y/Cr/sub z/)/sub w/Al/sub (1-w)/O_3 where x = 0.9 to 1.05, y = 0.02 to 0.2, z = 0.8 to 1.05, and w = 1.0 to 0.5. (WHK)

10226 **Treatment of electrochemical cell components with lithium tetrachloroaluminate ($LiAlCl_4$) to promote electrolyte wetting.** Eberhart, J.G.; Battles, J.E. (to Dept. of Energy). US Patent Application 957,619. 3 Nov 1978. 9p.

Electrochemical cell components such as interelectrode separators, retaining screens and current collectors are contacted with lithium tetrachloroaluminate prior to contact with molten electrolytic salt to improve electrolyte wetting. The $LiAlCl_4$ can be applied in powdered, molten or solution form but, since this material has a lower melting point than the electrolytic salt used in high-temperature cells, the powdered $LiAlCl_4$ forms a molten flux prior to contact by the molten electrolyte when both materials are initially provided in solid form. Components of materials such as boron nitride and other materials which are difficult to wet with molten salts are advantageously treated by this process.

DUCT ENGINEERING AND FLUID DYNAMICS

10227 (AD-A—070080) **Hartmann flows in the MHD generator configuration. Technical report.** Elkins, R.E. III; Trovillion, T.A.; Lindgren, E.R. (Florida Univ., Gainesville (USA). Dept. of Engineering Sciences). Jun 1979. Contract N00014-76-C-0410. 60p. NTIS PC A04/MF A01.

Specific features and characteristics of Hartmann flows in the Faraday generator configuration are reported. These features concern the effect of longitudinal baffling along the insulating duct walls and effects of slip between gas-liquid phases in the flow. The report also contains an analysis of a compensating system of a Faraday generator as well as a one-dimensional zero-slip model of a two-phase MHD flow through the generator.

10228 (N—79-18758) **Experimental investigation on the discharge structure in a noble gas MHD generator.** Borghi, C.A.; Sens, A.F.C.; Veefkind, A.; Rietjens, L.H.T. (Technische Hogeschool Eindhoven (Netherlands)). Jan 1978. 22p. NTIS PC A02/MF A01.

An experimental investigation of the discharge structure in a noble gas MHD plasma has been performed, employing streak photography and other optical diagnostics. The discharge appeared to be concentrated in streamers. It was observed that the streamer structure of the discharge is very pronounced at stagnation temperatures around 2000 K, where the conductivity of the plasma becomes critical. Moreover, the observations indicate the presence of friction forces which result in a velocity of the streamers being always close to the velocity of the gas flow. The observations suggest that streamers are generated by break down phenomena at the inlet of the generator and subsequently convected downstream the channel. The structure of the discharge in the direction perpendicular to the electrode walls was analyzed by taking streak pictures with the slit in this direction in order to obtain information about the angle of propagation of the streamers.

THERMOELECTRIC GENERATORS

DESIGN AND DEVELOPMENT

10229 **Hydrostatically extruded thermoelectric legs.** Hampl, E.F. Jr. (to Minnesota Mining and Manufacturing Co.). US Patent 4,161,111. 17 Jul 1979. Filed date 10 Feb 1978. 6p.

Thermoelectric legs of useful durability may be prepared by hydrostatic extrusion. In cross-section, the legs may have either circular or non-circular shapes of special usefulness, and the legs may be formed in narrow elongated sizes, which are useful in compact, high-voltage thermoelectric converters.

THERMIONIC CONVERTERS

DESIGN AND DEVELOPMENT

10230 (COO—3056-36) **DOE/JPL advanced thermionic technology program. Progress report No. 36, October-November 1978. Report No. TE4258/4247-89-79.** (Thermo Electron Corp., Waltham, MA (USA)). 1978. Contract EY-76-C-02-3056. 82p. Dep. NTIS, PC A05/MF A01.

Progress is reported on DOE tasks including: (1) thermionic converter plasma studies; (2) low temperature converter development; (3) component hardware development; and (4) combustion heated thermionic device. JPL tasks described include: (1) basic surface experiments; (2) triode converter experiments; (3) design of a cylindrical converter; and (4) high efficiency conversion experiments. (WHK)

10231 (COO—3056-41) **DOE/JPL advanced thermionic technology program. Progress report No. 39, April-June 1979. Report No. TE4258/4247-2-80.** (Thermo Electron Corp., Waltham, MA (USA)). 1979. Contract EY-76-C-02-3056. 73p. Dep. NTIS, PC A04/MF A01.

DOE tasks include surface and plasma investigations (surface characterization, spectroscopic plasma experiments, and converter theory); low-temperature converter development (tungsten emitter, tungsten oxide collector and tungsten emitter, nickel collector); component hardware development (hot shell development); and flame-fired CVD silicon carbide converters. JPL tasks include high temperature and advanced converter studies, postoperational diagnostics, and correlation of design interfaces. Progress on each of these tasks is reported. (WHK)

10232 (N—79-18711) **Investigations of negative and positive cesium ion species. Final report.** Chanin, L.M. (Minnesota Univ., Minneapolis (USA). Dept. of Electrical Engineering). Sep 1978. 35p. NTIS PC A03/MF A01.

A direct test is provided of the hypothesis of negative ion creation at the anode or collector of a diode operating under conditions simulating a cesium thermionic converter. The experimental technique involves using direct ion sampling through the collector electrode with mass analysis using a quadrupole mass analyzer. Similar measurements are undertaken on positive ions extracted through the emitter electrode. Measurements were made on a variety of gases including pure cesium, helium-cesium mixtures and cesium-hydrogen as well as cesium-xenon mixtures. The gas additive was used primarily to aid in understanding the negative ion formation processes. Measurements were conducted using emitter (cathode) temperatures up to about 1000 F. The major negative ion identified through the collector was Cs(-) with minor negative ion peaks tentatively identified as H(-), H2(-), H3(-), He(-) and a mass 66. Positive ions detected were believed to be Cs(+), Cs2(+) and Cs3(+).

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 10230, 10231

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 10230, 10231

10233 **Distributed electrical leads for thermionic converter.** Fitzpatrick, G.O.; Britt, E.J. (to Dept. of Energy). US Patent 4,151,438. 24 Apr 1979. Filed date 17 Aug 1977. 4p.
PAT-APPL-825,518.

In a thermionic converter, means are provided for coupling an electrical lead to at least one of the electrodes thereof. The means include a bus bar and a plurality of distributed leads coupled to the bus bar each of which penetrates through one electrode and are then coupled to the other electrode of the converter in spaced apart relation. 6 claims.

FUEL CELLS

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 10235

MATERIALS, COMPONENTS, AND AUXILIARIES

10234 (AD-A—066602) **Non-wetting materials for fabrication of fuel cell electrodes. Final technical report.** Mack, R.; Bruckenstein, S. (State Univ. of New York, Buffalo (USA). Dept. of Chemistry). Dec 1977. Contract DAAG53-76-C-0026. 64p. NTIS, PC A04/MF A01.

A study of propane electrooxidation on a platinum coated ion exchange membrane was conducted in both 85% phosphoric acid and trifluoromethanesulfonic acid monohydrate (TFMSA). The phosphoric acid system's propane electrooxidation currents were characterized with respect to temperature, propane flow rate and oxidation potential. Then, the propane electrooxidatin currents of the TFMSA system were determined and compared to the phosphoric acid system. The steady state currents in the TFMSA solvent were two times greater than in the 85% H3PO4 acid solvent. Steady state hydrogen electrooxidation current measurements were made in both solvents and compared to the propane electrooxidation currents to estimate the practicability of propane electrooxidation. On a mole basis, the propane currents were 1/143 of the hydrogen currents.

APPLICATIONS

10235 (BNL—51047) **Development of fuel cell technology for vehicular applications. Annual report, October 1, 1977-September 30, 1978.** McBreen, J.; Taylor, E.J.; Kordesch, K.V.; Kissel, G.; Kulesa, F.; Srinivasan, S. (Brookhaven National Lab., Upton, NY (USA)). May 1979. Contract EY-76-C-02-0016. 108p. Dep. NTIS, PC A06/MF A01.

A survey of the present state-of-the-art of fuel cells and batteries suitable for hybrid fuel cell/battery power plants is presented. Also given are a systems study on phosphoric acid fuel cells for transportation applications and the results of an experimental study of phosphoric acid and alkaline fuel cells under conditions of intermittent operation. A review of fuel options and fuel processing for fuel cells is included. (WHK)

ELECTROCHEMISTRY, MASS TRANSFER, AND THERMODYNAMICS

REFER ALSO TO CITATION(S) 10234

10236 (ORNL/TM—7014) **Relaxation of electrode potential difference, temperature gradient and pressure gradient in electrolyzed fuel cell tiles. Molten carbonate fuel cell program. Progress report for period April 1-June 30, 1979.** Braunstein, J.; Bronstein, H.R.; Smith, D.H. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

This report describes results obtained in the period April 1-June 30, 1979 on the analysis of relaxation of electrode potential differences, temperature gradients and pressure gradients induced by current flow in fuel cell tiles subjected to electrolysis. Progress has been made in resolving the magnitudes and time values of some of the processes contributing to the observed relaxations. Experiments have continued on the measurement of transference numbers in molten Li_2CO_3-K_2CO_3.

10237 **Nonequilibrium thermodynamics of fuel cells: Heat release mechanisms and voltage.** Wilemski, G. (Physical Sciences, Inc., Woburn, Massachusetts 01801). *J. Chem. Phys.;* **72**: No. 1, 369-377(1 Jan 1980).

Nonequilibrium thermodynamics is used to analyze the spatial distribution of heat release mechanisms occurring in fuel cells operating under load in nonisothermal steady states. Novel contributions to heat release in the bulk electrolyte are found which are analogous to Peltier and Thomson effects in metallic conductors. Expresions for the heat release at individual electrodes are presented. An equation for the voltage of these cells is also derived.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

10238 (DOE/ET—2442-1) **Regional application of fossil energy technologies: an analytical approach. Final report.** Rebello, W.; Canete, D.; Phipps, H.; Smith, R. (Systems Consultants, Inc., Washington, DC (USA)). Sep 1979. Contract EX-76-C-01-2442. 312p. Dep. NTIS, PC A14/MF A01.

Energy supply/demand profiles are presented for the 50 states and the nine US census regions using 1974 statistics. These profiles include quantity and type of energy reserves, annual primary resource production, and consumption by end-use sector. Each state's and region's energy balance is presented for fossil fuels, quantitatively designating the state or region as a net importer or exporter of these fuels. Finally, the dependence of each consumption sector on each energy source is tabulated. A major part of the project was devoted to the development of a method for use by energy planners in assessing the effects of policy decisions on energy profiles. A series of energy indices is derived for each census region. The indices are defined to include the effect of consumption of relatively scarce fuels (oil and gas) versus plentiful fuels (coal). The fuel-weighting factors, incorporated into the indices, are based upon national depletion rates, i.e., production. The energy indices technique can be used as a basis for comparisons between consumption sectors in a region, similar sectors in two or more regions, etc. A number of fossil-energy technologies under development at DOE are described. The potential impact of the maturation of these technologies on each census region's energy posture is discussed in conjuncton with any regional constraints that may exist. Finally, a number of sample what if scenarios are discussed and the impact of fossil-fuel replacements on national, regional, and sector energy consumption quantitatively assessed.

BUILDINGS

10239 Energy required for building construction. Stein, R.G.; Serber, D. pp 182-203 of Energy conservation through building design. Watson, D. (ed.). New York, NY; McGraw-Hill, Inc. (1979).

The energy required to construct new buildings and to repair and maintain existing buildings is analyzed in terms of the energy cost of producing, processing, transporting, fabricating, and installing the major types of building materials, i.e., wood, metals, concrete products, glass, etc. Tabulated data are included on the embodied energy per pound in materials before and after delivery to the job site, and for the embodied energy and annual operating energy of buildings that are identical except for insulation thickness and window glazing. The modeling of energy demand for building construction is discussed. It is concluded that a 20% reduction in the energy requirements for constructing U.S. buildings is feasible. This would be the energy equivalent of half of the US oil imported from Saudi Arabia in 1975. (LCL)

10240 (DOE/CS—0116) **Proposed energy-performance standards for new buildings: climate classification analysis. Technical support document.** (Department of Energy, Washington, DC (USA)). Nov 1979. 258p. Dep. NTIS, PC A12/MF A01.

The objectives and findings of the climate classification analysis conducted by DOE in support of the program to develop the energy-conservation standards for new buildings are summarized. The analysis addresses the relationships between weather variables and the design energy requirements of buildings. An equitable climate classification system to develop, present, and apply the standards is defined. The climate classification system is based on an evaluation of the geographic variation in building DER estimates, using the methodology discussed in Section 2.0. Initially, seven climate regions, based on heating and cooling degree-days, were seven developed as a statistical stratification device. These seven regions were presented in the Advance Notice of Proposed Rulemaking on the standards, published in the FEDERAL REGISTER on November 21, 1978. Since then, DOE has oriented an ongoing research effort toward a more equitable climate-classification system. The research effort to date has included an assessment of both the effectiveness with which degree-days explained geographic variations in DER and the effectiveness of other climate variables (such as solar insolation, humidity, etc.) in explaining such variations, either independently or in conjunction with temperature-based variables.

10241 (DOE/CS—0118) **Proposed energy-performance standards for new buildings: standard building operating conditions. Technical support document.** (Department of Energy, Washington, DC (USA)). Nov 1979. 79p. Dep. NTIS, PC A05/MF A01.

The process of developing Energy Budget Levels for new commercial buildings, in conjunction with the energy-performance standards for new buildings, includes the use of energy-analysis computer programs. These programs are used to estimate the design energy requirements of randomly selected commercial buildings comprising the study sample in both the Phase I and Phase 2 studies conducted by the American Institute of Architects Research Corporation. The input to these programs includes a set of data known as the Standard Building Operating Conditions (SBOC). These SBOC consist of temperatures, human-occupancy densities and profiles, lighting-usage profiles, and the like. They describe typical conditions under which a commercial or multifamily residential building would operate during the course of a day. This report (a) describes which building operating conditions were standardized, and how this was done in the AIA/RC team research efforts in Phases 1 and 2, which developed an information base for use by DOE in the development of the standards; (b) discusses alternative ways that SBOC may be applied in a regulatory compliance context, and the advantages and disadvantages of each alternative; (c) examines some of the implications of the standardization of operating conditions; and (d) provides, for use with the Standard Evaluation Technique, SBOC that are reasonable, based on the research conducted, and that provides an equitable basis for comparing annual Design Energy Consumption estimates of buildings against Design Energy Budgets.

10242 (DOE/CS—0120) **Proposed energy-performance standards for new buildings: the standard evaluation technique. Technical support document.** (Department of Energy, Washington, DC (USA)). Nov 1979. 337p. Dep. NTIS, PC A15/MF A01.

An evaluation technique is a requirement of Pub. L. 94-385, which mandated the development of the standards. It is used to determine if the Design Energy Consumption (DEC) of a new building design is not greater than the Design Energy Budget (DEB), as determined from the proposed rule. While such an evaluation technique could be used for purposes other than demonstrating a building design's compliance with the DEB's, the discussion here is limited to this particular application. In general, the evaluation technique for the proposed standards is composed of 3 major elements: an energy calculation method, fixed parameters which establish a consistent basis for comparing the DEC of a building design to its DEB; and procedures for the combined use of both the calculation method and the fixed parameters. The application of the evaluation technique to specific building classifications which incorporate a wide variety of architectural features, heating, ventilating, and air-conditioning (HVAC) systems, as well as domestic hot water heating systems, which use nonrenewable and some renewable energy sources is defined. The selection process leading to DOE's choice of computer simulation programs for the Standard Evaluation Technique is discussed.

10243 (LBL—8394) **Intercomparison of tracer gases used for air infiltration measurements.** Grimsrud, D.T.; Sherman, M.H.; Janssen, J.E.; Pearman, A.N.; Harrje, D.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract W-7405-ENG-48. 16p. (CONF-800206—2). Dep. NTIS, PC A02/MF A01.

From American Society of Heating, Refrigeration, and Air Conditioning Engineers semi-annual meeting; Los Angeles, CA, USA (3 Feb 1980).

A direct intercomparison has been made between common tracer gases used to measure air infiltration rates in buildings. The results indicate that air exchange rates measured using sulfur hexafluoride, SF_6, are slightly larger than those measured using methane, CH_4, or nitrous oxide, N_2O. The ratio of air change rates measured using SF_6 to air change rates measured concurrently using a lighter tracer gas was found to be 1.10 +- 0.10.

10244 (NTIS/PS—79/0556) **Energy conservation: buildings. Volume 2. 1977-April 1979 (a bibliography with abstracts). Report for 1977-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 233p. NTIS PC N01/MF N01.

Energy conservation in residential, commercial, and industrial buildings through use of efficient heating, air conditioning, and lighting systems is discussed. Topic areas cover the retrofitting of existing buildings, methods of detecting heat loss, efficient use of electric power, and economics of energy conservation options. A few abstracts deal with general studies on the potential for conserving energy in buildings and guidelines for building owners. Subject areas excluded from this bibliography but available as separate Published Searches are energy conservation through building design, waste heat utilization, total energy systems, and heat pumps. (This updated bibliography contains 227 abstracts, 71 of which are new entries to the previous edition.)

10245 (PB—293082) **Building research at the National Bureau of Standards 1968 - 1974. Building science series.** Gallagher, N. (National Bureau of Standards, Washington, DC (USA). Center for Building Technology). Mar 1979. 132p. NTIS PC A07/MF A01.

This report details the progress of building research at the Center for Building Technology from the year 1968 to 1974. Starting with the backlog of needed research in building techniques, components, and materials that faced researchers in the 60's, this history covers the evolution of the performance concept for building specifications, cooperation with states and codes-generating organizations, and specific technical accomplishments. The report continues with discussions of programs involving the building community, research on the needs of the building users, and technology transfer. A special chapter is devoted to energy conservation in buildings and how CBT's test methods and other programs - including solar - were pressed into this vital national struggle.

RESIDENTIAL BUILDINGS

10246 (CONF-7910105—1) **Residential heating-efficiency developments.** Macriss, R.A. (Institute of Gas Technology, Chicago, IL (USA)). 1979. 9p. Inst. of Gas Technology, Chicago, IL.

From 2. world energy engineering conference; Atlanta, GA, USA (28 Oct 1979).

A large number of developments are under way in the US aimed at providing new high-efficiency, space-heating equipment for existing and for new single- and two-family dwellings. The majority of these developments are supported by the US gas industry (through the Gas Research Institute and the American Gas Association), by the US Government, and by private gas companies and gas-equipment manufacturers. This paper presents a current account of several of these developments, with special emphasis on near-to-midterm hardware for retrofit or replacement of existing equipment, and for new construction. A brief explanation of the key elements that differentiate similar developments from each other is also presented, as is, when possible, an account of the technical and economic goals and marketability assumptions. A brief presentation of the status of other, longer-term, developments and equipment (such as heat pumps, etc.) is also given.

10247 (DOE/CS—0117) **Proposed energy-performance standards for new buildings: passive and active solar-heating analysis. Technical support document.** (Department of Energy, Washington, DC (USA)). Nov 1979. 70p. Dep. NTIS, PC A04/MF A01.

The standards being developed by DOE for new buildings will establish maximum permissible levels of annual building Design Energy Consumption for different building types in various climates. Besides reducing the use of depletable energy, the standards are intended to achieve maximum practicable increases in the use of nondepletable sources of energy. In the process of setting the standards, an economic analysis was conducted, using the annual life-cycle cost method for energy conservation measures in new single-family residential buildings. That analysis was conducted by Battelle PNL and LBL and is documented in Technical Support Document, Economic Analysis. This present analysis evaluates the use of both passive and active solar thermal heating technologies, providing cost and energy savings estimates for optimally-sized passive solar systems corresponding to the prototype house characteristics represented by each point on the conservation cost/performance curves (from the previous studies). An anlysis was performed for each of the ten (Atlanta, Burbank, Chicago, Fresno, Ft. Worth, Houston, Minneapolis, Phoenix, Portland, and Washington) representative cities in the conservation study analysis. The key elements of this methodology are: thermal performance estimation, optimum system size determination, and sensitivity analysis. (MCW)

10248 (DOE/CS/20315—T7) **Utility and performance relative to consumer product energy efficiency standards. Final technical report.** Coggins, J.L. (Energy Applications, Columbia, MD (USA)). 14 Dec 1979. Contract AC03-79CS20315. 66p. Dep. NTIS, PC A04/MF A01.

An investigation of the relative utility and performance of nine major household consumer products covered by the Energy Policy and Conservation Act is summarized. The objective was to define the terms utility and performance, to recommend methods for quantifying these two concepts, and to recommend an approach for dealing with utility and performance issues in the energy efficiency standards program. The definitions developed are: performance of a consumer product is the objective measure of how well, with the expected level of consumer input (following the manufacturer's instructions for installation and operation), the product does its intended job; and utility of a consumer product is a subjective measure, based on the consumer's perception, of the capability of the product to satisfy human needs. Quantification is based on test procedures and consumer survey methods which are largely already in use by industry. Utility and performance issues are important in product classification for prescribing energy efficiency standards. The recommended approach to utility and performance issues and classification is: prior to setting standards, evaluate utility and performance issues in the most quantitative way allowed by resources and schedules in order to develop classification guidelines. This approach requires no changes in existing Department of Energy test procedures.

10249 (DOE/EIS—0050) **Residential Conservation Service program. Final environmental impact statement.** (Department of Energy, Washington, DC (USA)). Nov 1979. 428p. Dep. NTIS, PC A19/MF A01.

Proposed is the establishment of the Residential Conservation Service Program to implement Part 1 of Title II of the National Energy Conservation Policy Act (P.L. 95 to 619). The proposed program would require large regulated and nonregulated utilities with specified residential sales to prepare and administer programs of consumer information and services, including home energy audits, designed to promote the installation of energy-conservation and renewable-resource measures in residential buildings. Among the energy-conservation measures currently included in the RCS Program are caulking and weatherstripping; certain furnace-efficiency modifications; insulation of ceilings, walls, floors, pipes, ducts, and water heaters; storm windows and doors; thermal windows and doors; and clock thermostats. Among the renewable resource measures currently included are active solar space-heating and hot-water systems; passive solar space-heating and cooling systems; and wind energy devices. The range of alternatives considered for the program includes the scope and duration of post-installation inspections, the scope of installation standards for loose-fill insulation, and a material standard for attic insulation.

10250 (INKA-Conf—79-095-009) **Process of measurement for investigating domestic (electrical) loads.** Lange-Huesken, M. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)). 1979. 19p. (In German). (CONF-7905117—7). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on power demand and supply - analysis and strategies; Schliersee, F.R. Germany (16 May 1979).

It is shown that tape recorder with load inputs equipment can be used with electronic data processing equipment to obtain a closer idea of the typical overall domestic loads. Accordingly, it is unnecessary to carry out separate measurements of the load and work of each individual piece of equipment which consumes appreciable amounts of power. This would require a much more expensive and less compact measuring device. This measurement is sufficient for maximum work and maximum demand calculations and for the simultaneous detection of the operating periods of the equipment with the highest power consumption via load inputs, in order to be able to carry out an accurate analysis according to power applications using the electronic data processing equipment. One can claim high accuracy, as control measurements show that deviations from effective measured value in this process are not more than 10 in the worst case, but are usually less than 5.

10251 (NTIS/PS—79/0549) **Energy conservation through building design (citations from the NTIS data base). Report for 1964-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 96p. NTIS PC N01/MF N01.

Federally-funded research on energy conservation through design of residential and commercial buildings is discussed. Topic areas cover the impact of building codes and standards on new construction and retrofitting of existing buildings, energy calculations for new building design, methods for estimating life cycle costs of alternative energy conservation techniques, inclusion of thermal insulation during building design, and window strategies. (This updated bibliography contains 91 abstracts, 43 of which are new entries to the previous edition).

10252 (NTIS/PS—79/0550) **Energy conservation through building design (citations from the Engineering Index data base). Report for 1970-April 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 114p. NTIS PC N01/MF N01.

Citations from worldwide literature on energy conservation through design of both residential and non-residential buildings are discussed. Topic areas cover solar radiation considerations in building planning and design, daylighting and window design, use of computer graphics for buildings, and architectural design concepts. (This updated bibliography contains 108 abstracts, 36 of which are new entries to the previous edition.)

10253 (PB—294293) **Design optimization and field verification of an integrated residential furnace. Phase I. Report for August 1976-December 1978.** Okunda, A.S.; Combs, L.P. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). Feb 1979. Contract EPA-68-02-2174. 157p. NTIS, PC A08/MF A01.

The report describes Phase 1 of a two-phase investigation to: (1) further optimize the design of a prototype low-emission residential furnace that was derived from earlier EPA-funded studies; and (2) obtain field verification of its emission and performance characteristics. It gives details of: (1) analytical and experimental studies to optimize the furnace design and its nominal operating ranges, and to ensure conformance with appropriate safety standards; (2) planning all aspects of the Phase 2 field test investigation, including selection of test locales and host homes, provision of local installation and service support, and all logistic and scheduling considerations; and (3) studies of the integrated furnace's capabilities to function properly with such alternate fuels as natural gas and methanol. The prototype furnace, with a cast iron firebox, met all emission goals (i.e., NOx less than 0.65 g/kg, CO less than 1.0 g/kg, UHC less than 0.1 g/kg, and a Bacharach smoke number less than 1) at low excess air (20%). Based on climatic characteristics and available support services, Albany and Boston were selected for field verification of furnace performance.

10254 **Effects of the National Energy Act on energy use and economics in residential and commercial buildings.** Hirst, E. (Oak Ridge National Lab., TN). Contract W-7405-ENG-26. *Energy Syst. Policy;* 3: No. 2, 171-190(1979).

In 1977 heating, cooling, lighting, and other operations in residential and commercial buildings used 27 QBtu of energy. This is more than one-third of the nation's total energy budget. Future trends in energy use in buildings are likely to depend strongly on fuel prices and government policies to save energy. Four scenarios are examined: (1) a high case in which real fuel prices remain constant from 1976 through 2000, (2) a baseline in which fuel prices rise as projected by DOE, (3) a conservation case that includes higher electricity and gas prices plus the regulatory, financial incentive, and information programs of the 1978 National Energy Act and preceding Federal legislation, and (4) another conservation case that also includes new technologies (more efficient equipment, appliances, and structures). These scenarios are analyzed using two detailed engineering-economic models of energy use in residential and commercial buildings developed at ORNL. Energy use in the year 2000 ranges from a high of 47 QBtu to a low of 32 QBtu with these four scenarios. Growth rates in energy use in buildings for the 1977 to 2000 period range from 2.7 to 1.0%/y, compared with the historical growth rate of 4.0%/y from 1950 to 1977. Commercial energy growth is always faster than residential growth. Adopting the conservation programs of scenarios 3 and 4 cuts cumulative (1977 to 2000) energy use by 76 QBtu. These programs reduce the present worth (8% real interest rate) of energy-related expenditures by $34 billion.

10255 (OA-tr—2181) **Thermal insulation of new dwellings: how do we obtain a satisfactory G factor.** Catherineau, M.; Guerin, R. Translated from *Moniteur;* No. 43, 108-109(25 Oct 1975). 9p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The Order issued under Decree No. 74-306 of 10 April 1974 stipulates limits of the volumetric thermal loss factor G for each type of dwelling, detached or otherwise. These limits mean appreciably increasing the thermal insulation currently employed, which is not without some effect on the cost of a building project. To understand the problem of the cost of insulation, or more correctly, the extra cost of insulation generally necessary to improve the volumetric thermal loss factor G, there are different approaches. The first, called the overall method, takes the whole of the building into consideration. The second, or fine method, involving data processing, enables a much more accurate heat balance to be drawn up, apartment by apartment, in accordance with the meaning of the Decree. The general lines of the overall method, are explained.

OFFICE BUILDINGS

10256 (COO—2799-T1) **Energy conservation in existing office buildings. Volume 1. Phase 1.** (Tishman Research Corp., New York (USA); Syska and Hennessy, New York (USA)). Jun 1977. Contract EY-76-C-02-2799. 56p. Dep. NTIS, PC A04/MF A01.

The goal of this study is to bring together sufficient information, in the office part of the commercial building sector, to permit the proposal of a strategy for energy conservation. The research is based on an examination of more than 1000 office buildings containing about 250 million square feet of gross space in New York City. Of eight specific objectives in the study, the objective of Phase I is to determine the physical and operational energy-related characteristics of office buildings and energy-consumption patterns. The steps in the first phase consist of: classification and description of the major office-building inventory in terms of building characteristics that appear to bear upon energy consumption; selection of a sample; obtaining pertinent data on levels of energy use; analyzing the data and information obtained; categorizing and explaining differences; and comparing energy consumption before and after the 1973 oil embargo. A brief questionnaire was developed and distributed to 1013 building owners to obtain as much preliminary information as possible; 505 usable returns were received, of which 69 were further culled as not representative, record deficiencies, etc., leaving 436. (MCW)

10257 (COO—2799-T2) **Energy conservation in existing office buildings. Appendices to report, Phase I, Volume 2.** (Syska and Hennessy, New York (USA); Tishman Research Corp., New York (USA)). Jun 1977. Contract EY-76-C-02-2799. 612p. Dep. NTIS, PC A99/MF A01.

A blank form of Questionnaire No. 1 is first presented, followed by data compiled from that questionnaire. Then data are presented on the analyses of the 436 buildings, statistical validation for selection of the 44 building sample, and some examples of the matching buildings for the 44 building sample. Questionnaire No. 2 is then given, followed by additional data collected from the study concerning energy consumption and building characteristics. To complete the appendices, a simulation of a typical building and a hypothetical building is included. (MCW)

10258 (COO—2799-T3) **Energy conservation in existing office buildings. Final report.** (Syska and Hennessy, New York (USA); Tishman Research Corp., New York (USA)). Nov 1978. Contract EY-76-C-02-2799. 13p. Dep. NTIS, PC A02/MF A01.

Part I of this report summarizes the following: goals, methodology, energy savings since the oil embargo, owner known information, characteristics of office buildings, retrofit potential and strategies, actual consumption vs design projections, overcoming barriers, consumption budgets, and applicability of recommendations and methodologies. Part II summarizes the recommendations. (MCW)

10259 (COO—2799-T4) **Energy conservation in existing office buildings. Phase III.** (Syska and Hennessy, New York (USA); Tishman Research Corp., New York (USA)). Aug 1978. Contract EY-76-C-02-2799. 38p. Dep. NTIS, PC A03/MF A01.

Phase III deals with the constraints and/or the adverse consequences of possible conservation measures and how to overcome any barriers. Further, it develops realistic energy-consumption budgets, if it is determined that this is the proper approach; if not, it proposes an alternate approach; and it indicates applicability to other building types and geographical regions of the US. This report concerns itself with the findings, and conclusions with respect to these issues are given. Also included in the appendix is a revision of Questionnaire No. 2, a uniform building energy information form. (MCW)

10260 (COO—2799-T5) **Energy conservation in existing office buildings. Phase II.** (Syska and Hennessy, New York (USA); Tishman Research Corp., New York (USA)). Jun 1978. Contract EY-76-C-02-2799. 230p. Dep. NTIS, PC A11/MF A01.

Phase II deals with establishing the potential value and feasibility of retrofitting conservation measures and determining how best to achieve desired energy savings practically in office buildings in New York City. Five buildings were selected for detailed study. The following steps were taken: performed survey work to include examination and measurements to gather data of the building envelopes, interior loads in the space, heating, ventilating, air conditioning, plumbing and electrical equipment; used AXCESS program to determine energy consumption for the service systems and compared the energy consumption in the systems; developed retrofit energy conservation programs for the five buildings beyond those already achieved voluntarily since the energy crisis and determined the economic, technical, and practical feasibility for achieving these additional savings; and estimated the energy savings for all New York City office buildings. (MCW)

SCHOOL, MUNICIPAL AND OTHER PUBLIC BUILDINGS

REFER ALSO TO CITATION(S) 10254

10261 (AD-A—064384) **Study of army building ventilation systems for energy conservation. Final report 1 Oct 77—1 Aug 78.** Wrobel, J.R. (Jacobs Associates, Inc., Hampton, VA (USA)). 1 Aug 1978. Contract DAAK70-77-C-0217. 148p. NTIS PC A07/MF A01.

A generalized analysis of fixed base facility ventilating equipment is presented to describe practical technical and cost-effective energy conservation goals and prospects for future equipment development. (Author)

10262 (AD-A—066513) **Fixed facilities energy consumption investigation -- data analysis. Interim report.** Sliwinski, B.J.; Leverenz, D.; Windingland, L.; Mech, A.R. (Army Construction Engineering Research Lab., Champaign, IL (USA)). Feb 1979. 46p. NTIS, PC A03/MF A01.

This report describes the analysis of energy consumption data collected between September 1976 and February 1978 for selected Army buildings at Fort Belvoir, VA, Fort Carson, CO, and Fort Hood, TX. These buildings represent seven major energy consumer groups found on Army installations: family housing, troop housing, administration/training, production/maintenance, medical/dental, storage, and community support facilities. Results of analyses of building energy consumption vs. building floor area and weather parameters are presented in Btu/sq/ft/heating degree days (HDD) and kWh/sq ft/cooling degree days (CDD) for each consumer group. Comparisons between consumer groups are shown graphically on bar charts; energy use data for each consumer group are used to develop charts showing installation energy use by consumer groups.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 10251, 10252

TRANSPORTATION

10263 (NTIS/PS—79/0557) **Energy conservation: transportation. Volume 1. 1964-1977 (a bibliography with abstracts). Report for 1964-1977.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Jun 1979. 257p. NTIS PC N01/MF N01.

The potential to achieve fuel conservation through technology, management, and planning is discussed. Transportation areas covered include urban mass transit, aviation, marine transportation, automobiles, trucks, and railroads. A few abstracts discuss public attitudes concerning conservation measures. (This updated bibliography contains 250 abstracts, none of which are new entries to the previous edition.)

AIR AND AEROSPACE

10264 (N—79-17851) **Effects of laminar flow control on the performance of a large span-distributed-load flying-wing cargo airplane concept.** Jernell, L.S. (National Aeronautics and Space Administration, Langley AFB, VA (USA). Langley Research Center). Jun 1978. 23p. NTIS PC A02/MF A01.

The effects of laminar flow control (LFC) on the performance of a large span-distributed-load flying-wing cargo airplane concept having a design payload of 2.669 MN and range of 5.93 Mm were determined. Two configurations were considered. One employed laminarized flow over the entire surfaces of the wing and vertical tails, with the exception of the estimated areas of interference due to the fuselage and engines. The other case differed only in that laminar flow was not applied to the flaps, elevons, spoilers, or rudders. The two cases are referred to as the 100 percent and 80 percent laminar configurations, respectively. The utilization of laminar flow control results in reductions in the standard day, sea level

installed maximum static thrust per engine from 240 kN for the non-LFC configuration to 205 kN for the 100 percent laminar configuration and 209 kN for the 80 percent case. Weight increases due to the LFC systems cause increases in the operating empty weights of approximately 3 to 4 percent. The design takeoff gross weights decrease approximately 3 to 5 percent. The FAR-25 takeoff field distances for the LFC configurations are greater by about 6 to 7 percent. Fuel efficiencies for the respective configurations are increased 33 percent and 23 percent.

10265 (N—79-18057) **Study of hydrogen recovery systems for gas vented while refueling liquid-hydrogen fueled aircraft.** Baker, C.R. (Union Carbide Corp., Tonawanda, NY (USA)). Feb 1979. Contract NAS1-14698. 70p. NTIS PC A04/MF A01.

Methods of capturing and reliquefying the cold hydrogen vapor produced during the fueling of aircraft designed to utilize liquid hydrogen fuel were investigated. An assessment of the most practical, economic, and energy efficient of the hydrogen recovery methods is provided.

LAND AND ROADWAY

REFER ALSO TO CITATION(S) 9649

10266 (BNL—50901) **Energy and economic evaluation of policies for accelerated investment in efficient automobiles.** Brooks, W.; Carhart, S.C.; McGranahan, G.; Mulherkar, S.S. (Brookhaven National Lab., Upton, NY (USA)). Aug 1978. Contract EY-76-C-02-0016. 30p. Dep. NTIS, PC A03/MF A01.

This report examines the effect of an energy-conservation policy that imposes excise taxes on cars having low fuel efficiency, coupled with a rebate on cars having high fuel efficiency. Two oil price cases are considered. The Jack Faucett Automobile Sector Forecasting Model is used to measure direct effects. The Brookhaven National Laboratory-University of Illinois Input-Output/Linear Programming model is used for economy-wide effects and impact on employment.

10267 (PB—287029) **Application for certification 1978 model year light-duty vehicles - Alfa Romeo.** (Alfa Romeo, Inc., Englewood Cliffs, NJ (USA)). Mar 1978. 547p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10268 (PB—287030) **Application for certification for 1978 model year light-duty vehicles - Honda Motor Company.** (American Honda Motor Co., Inc., Gardena, CA). Mar 1978. 596p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10269 (PB—287031) **Application for certification for 1978 model year light-duty vehicles - Chrysler Corporation.** (Chrysler Corp., Detroit, MI (USA)). 3 May 1978. 230p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10270 (PB—287032) **Application for certification 1978 model year light-duty vehicles - Fiat.** (Fiat Research and Development, Dearborn, MI (USA). U.S.A. Branch). Mar 1978. 2410p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10271 (PB—287033) **Application for certification for 1978 model year light-duty vehicles - Renault.** (Renault Technical Center, Bellville, MI (USA)). Mar 1978. 787p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10272 (PB—287034) **Application for certification 1978 model year light-duty vehicles - Mercedes Benz.** (Mercedes-Benz of North America, Inc., Montvale, NJ). Mar 1978. 1770p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10273 (PB—287035) **Application for certification for 1978 model year light-duty vehicles - Rolls Royce Incorporated.** (Rolls Royce, Inc., Paramus, NJ (USA)). Mar 1978. 296p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10274 (PB—287036) **Application for certification 1978 model year light-duty vehicles - Volvo.** (Volvo of America Corp., Rockleigh, NJ (USA)). Mar 1978. 975p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10275 (PB—287037) **Application for certification for 1978 model year light-duty vehicles - Saab Scania.** (Saab-Scania of America, Inc., Orange, CT). Mar 1978. 453p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10276 (PB—287039) **Application for certification for 1978 model year motorcycles - American Honda Motor Company, Inc.** (American Honda Motor Co., Inc., Gardena, CA). Mar 1978. 1014p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10277 (PB—287040) **Application for certification for 1978 model year motorcycles - Suzuki Motor Company.** (United States Suzuki Motor Corp., Santa Fe Springs, CA). Mar 1978. 576p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10278 (PB—287041) **Application for certification 1978 model year light-duty vehicles and light-duty trucks - Isuzu Motors Ltd.** (Isuzu Motors Ltd., Southfield, MI (USA)). Mar 1978. 1244p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10279 (PB—287042) **Application for certification for 1978 model year light-duty vehicles - Toyo Kogyo - Mazda.** (Toyo Kogyo Co. Ltd., Southfield, MI (USA)). Dec 1977. 1123p. Also available in set of 14 reports PC$650.00/MF$25.00, PB-287 028-SET.

Every year each manufacturer of light-duty vehicles (passenger cars), light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the Part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, mileage or service accumulation procedures, fuels to be used, and proposed maintenance during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, statements of compliance with the regulations, and maintenance instructions to be provided to the ultimate owners of the vehicle.

10280 (PB—287051) **Application for certification for 1978 model year heavy-duty vehicles - General Motors Corporation, supplement.** (General Motors Technical Center, Warren, MI (USA)). Mar 1978. 199p. Also available in set of 9 reports PC$185.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10281 (PB—287052) **Application for certification for 1978 model year heavy-duty vehicles - International Harvester.** (International Harvester Co., Fort Wayne, IN (USA). Truck Engineering Center). Mar 1978. 1159p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10282 (PB—287053) **Application for certification for 1978 model year heavy-duty vehicles - General Motors corporation.** (General Motors Corp., Warren, MI (USA)). Mar 1978. 962p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to

be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10283 (PB—287054) **Application for certification for 1978 model year diesel heavy-duty engines - Caterpillar Tractor Company.** (Caterpillar Tractor Co., Peoria, IL (USA)). Mar 1978. 392p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10284 (PB—287055) **Application for certification for 1978 model year heavy-duty vehicles - Mack Trucks/Saab-Scania/Iveco-Unic-Fiat.** (Mack Trucks, Inc., Hagerstown, MD (USA)). Mar 1978. 1517p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10285 (PB—287056) **Application for certification for 1978 model year heavy-duty vehicles - Mitsubishi Motors Corporation.** (MMC Services, Inc., Southfield, MI (USA)). Mar 1978. 213p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10286 (PB—287057) **Application for certification 1978 model year heavy-duty diesel engines - Isuzu.** (Isuzu Motors Ltd., Southfield, MI (USA)). Mar 1978. 574p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10287 (PB—287059) **Application for certification for 1978 model year heavy-duty vehicles - Cummins Engine.** (Cummins Engine Corp., Columbus, IN (USA)). Mar 1978. 72p. Also available in set of 9 reports PC$285.00/MF$14.00, PB-287 050-SET.

Every year each manufacturer of passenger cars, light-duty trucks, motorcycles or heavy-duty engines submits to EPA an application for certification. The application consists of two parts. In the part I, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems, and exhaust and evaporative emission control systems. The part I also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. The part II application, submitted after emission testing is completed, contains the results of emission testing, a statement of compliance to the regulations, and maintenance instructions to be followed by the ultimate owners of the vehicles.

10288 (PB—294676) **Freight transportation petroleum conservation opportunities - viability evaluation. Final report, April 1977-1978.** Maio, D.J. (Department of Transportation, Cambridge, MA (USA). Transportation Systems Center). Mar 1979. 125p. NTIS, PC A06/MF A01.

This report develops a comprehensive perspective of current and near-term future energy demand in U.S. freight transportation. Synthesis of studies of many agencies indicate that the annual petroleum fuel demand for freight transportation in 1985 will be 5 billion gallons greater than that in 1975, even with a 7 billion gallon a year savings from conservation measures. This represents an increase in freight's share of the U.S. total transportation fuel demand from 23% to 29%, because of continued freight traffic growth and the greater savings potential in passenger systems. Freight transport by rail, by highway and by rail/highway intermodal services receives the most attention in this report because these modes offer the greatest promise for significant fuel savings. Fuel consumption and conservation estimates include both intercity and local truck operations, but intercity operations of the competitive, heavy-duty trucks and general merchandise trains are the primary focus because about 60% of the potential truck fuel savings and virtually all of the rail savings in 1985 are projected to come from intercity operations. Attention is focused on considerations of the transport market place supply and demand interactions in the evaluation of alternative government policies for fuel conservation in freight systems. An overall evaluation approach is presented, analytical tools appraised and several government policy alternatives are given a preliminary assessment. The results suggest that the most productive conservation strategies are those that focus on technological and operational improvements within the rail and highway modes having estimated savings of 28% and 18% respectively. Shifts of traffic to intermodal rail services although economically viable may prove counterproductive in certain markets in terms of energy consumption.

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 9750, 10659

ENERGY SOURCES

REFER ALSO TO CITATION(S) 9844, 10037, 10038, 10239

10289 (DOE/TIC—10006) **Report of the proceedings of the Department of Energy workshop on energy conservation in food distribution and preparation, March 30 and 31, 1978.** (Washington Scientific Marketing, Inc., DC (USA)). 1978. Contract W-31-109-ENG-38. 78p. 05.

In the opening general session, officials from DOE briefed workshop participants on the current DOE programs, plans, and objectives. Then summary reports and project recommendations were presented in the following areas: distribution and marketing, packaging, food service operations, and home preparation. (MCW)

10290 (SERI/TP—33-285, pp 330-332) **Thermal conversion of a biomass in a rotary kiln system.** Turpin, J.L. (Univ. of Arkansas, Fayetteville). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

A rotary kiln system is a viable processing alternative for the thermal conversion of biomass materials. It is a flexible system, accepting a wide variety of agricultural, forestry, and municipal wastes as feedstocks. The rotary kiln can be operated in various modes, ranging from complete incineration to pyrolysis of the feedstocks. Kiln products may be completely oxidized flue gases, gaseous and liquid fuels, solid char fuel, or a combination of these. Economical pollution control is achieved by these systems in a processing scheme which provides a clean atmospheric discharge of gases as the solid waste materials are eliminated. Finally, rotary kilns are de-

signed and constructed in a wide range of sizes with only minimal scale-up problems. the goals of the processing system to be discussed are (1) the elimination of solid waste materials in a non-polluting manner, (2) the utilization of off-gas process heat, and (3) the production of $75 per ton charcoal with an acceptable rate of return on the investment.

MATERIALS

10291 (COO—5011-3) **Sulfate specifications as a constraint to gypsum addition to cement and possible replacement of gypsum as an additive. Quarterly technical progress report, March-May 1979.** Kantro, D.L. (Portland Cement Association, Skokie, IL (USA). Construction Technology Labs.). Jun 1979. Contract EW-78-C-02-5011. 66p. Dep. NTIS, PC A04/MF A01.

Progress in research on potential alternatives to gypsum for controlling set in commercial concretes, additives to deter sulfate-induced expansion, and the influence of clinker manufacture on expansion potential in cements is reported. The purpose of these studies is to show that if limitations on sulfur content could be made less restrictive, it should prove possible to use kiln fuels with higher sulfur contents and to employ energy-efficient modern preheater kiln technology without risk of exceeding sulfate specifications in the finished product. The use of high sulfur fuels is desirable in that it allows high quality, low sulfur fuels to be reserved for key applications where substitution is technically impossible. The use of modern kiln technology is desirable from the point of view of saving energy. (LCL)

EQUIPMENT AND PROCESSES

10292 (ANL/OEPM—79-5) **Survey of organic electrolytic processes. Final report.** (Electrochemical Technology Corp., Seattle, WA (USA)). Nov 1979. Contract W-31-109-ENG-38. 272p. Dep. NTIS, PC A12/MF A01.

The basic objectives of this study were to review the literature to determine the commercial status of electroorganic processes and to estimate whether there would be significant possible energy savings by introduction of electroorganic processes to replace conventional chemical processes for production of certain large-tonnage organic chemicals. A list was compiled of the 220 organic chemicals that were produced at greater than 10,000 tons per year in 1975 in the United States. Search of the Swann and of the Fichter Bibliographies of electroorganic literature yielded references on 95 of these compounds. By application of selection rules to obtain promising candidates, nine chemicals with diverse electrochemical processes were chosen for detailed process energy calculations. Parallel calculations were made for presently-used commercial chemical routes to these products. Two of the nine electrochemical processes, adiponitrile and methyl ethyl ketone, had energy savings in comparison to the corresponding chemical processes. Other more-energy-efficient electrochemical processes are likely among the above 95, although they remain to be identified.

10293 (CONF-7910105—3) **Factors affecting the implementation of energy-conserving technology in industry.** Evans A.R.; Grogan, P.J.; Wyant, F.R. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 6p. Dep. NTIS, PC A02/MF A01.

From 2. world energy engineering conference; Atlanta, GA, USA (28 Oct 1979).

This paper discusses the major factors that determine the acceptability to industry of energy-conserving technology and the role that Federal policy plays in effecting the implementation of new technology. Several ongoing Argonne policy studies are described. A fluidized-bed, waste-heat boiler is considered as an example of a new technology whose implementation may be stimulated by possible future DOE demonstration and commercialization activities.

10294 (DOE/SF/40225—T1) **Shrimp monitor/locator for conservation of fuel. Final report.** (TRIAD and Associates, Inc., Corpus Christi, TX (USA)). 1 Jan 1980. Contract EM-78-C-03-2170. 151p. Dep. NTIS, PC A08/MF A01.

A demonstration project of a new type Shrimp Detector/Monitor has been completed. The test project proved the efficiency of the Shrimp Monitor/Detector in detecting shrimp, in identifying the number and size, in real time, but indicated that improvement could be effected which would enhance the operation. Data obtained from the test cruises indicate significant savings in diesel fuel will occur for those trawlers using the Shrimp Monitor/Detector in place of the usual trynet operation; 25% savings for the series model # 400, (the prototype tested) and expected 35%+ if the advanced series model # 500 were used. Fabrication and operational costs for the Shrimp Monitor/Detector are reasonable and well within the financial abilities of the usual large offshore trawler. Research and testing during this program resulted in the design of an advanced model incorporating significant improvements, and fabrication was commenced but the extra cost involved beyond the set value of this contract made the further experiments non-viable. Recommendations have been submitted for an extended program to fabricate and test the advanced model series # 500 which may be of more value and interest, market use, to the operating offshore shrimp trawlers. A marketing/sales program will be instituted to place the Shrimp Monitor/Detector in the commercial area serving the shrimp fleet.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 10130, 10131, 10132

10295 (N—79-18458) **Economical use of energy. Draft of a standard for heat recovery systems. Final report.** Bach, H.; Schlapmann, D. (Stuttgart Univ. (TH) (Germany, F.R.)). Dec 1977. 75p. NTIS PCA04/MF A01.

In relevant references there exist no consistent criteria for the judgement of heat recovery systems. The objective of this project was to give proposals to unify the design parameters, characteristic numbers and criteria to judge the energenic and economic qualitites of heat recovery devices and to have a basis for a standard. Parameters for the layout and specification of heat recovery devices were collected. Criteria for the judgement of such devices were developed to be installed and integrated in air conditioning systems. Temperature effectiveness for heat recovery systems with latent heat recovery is calculated. Annual load diagrams of the outdoor climate conditions were collected to estimate the annual heat recovery at different running modes. The results of this project is a standard draft with compilations of the annual energy saving of various heat recovery systems and running conditions.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 9599, 9740, 9753, 9754, 9756, 9759, 9760, 9761, 9762, 9763, 9764, 9768, 9856, 9857, 10290, 10562, 10599, 10601

MUNICIPALITIES AND COMMUNITY SYSTEMS

REFER ALSO TO CITATION(S) 10190, 10203

CONSERVATION SERVICES

REFER ALSO TO CITATION(S) 10202

10296 (N—79-18815) **Baltimore applications project. Annual progress report, June 1977—May 1978.** Golden, T.S.; Yaffee, P. (National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center). Jun 1978. 18p. NTIS PC A02/MF A01.

The Baltimore Applications Project (BAP) was originally designed as an experimental effort to assist the government of the City of Baltimore in applying technology to the solution of municipal problems. Recent modifications in the structuring and operation of the program are discussed. A tabular update on the individual tasks undertaken and their treatment is provided. Details of energy and nonenergy related tasks are presented in appendices.

PUBLIC UTILITIES

REFER ALSO TO CITATION(S) 9623, 9624

10297 (ANL/CNSV-TM—20) **Heat-pump-centered integrated community energy systems. Final report.** (Rocket Research Corp., Redmond, WA (USA)). Nov 1979. Contract W-31-109-ENG-38. 69p. Dep. NTIS, PC A04/MF A01.

Heat-pump-centered integrated community energy systems (HP-ICES) are energy systems for communities which provide heating, cooling and/or other thermal energy services through the use of heat pumps. Since heat pumps primarily transfer energy from existing and otherwise probably unused sources, rather than convert it from electrical or chemical to thermal form, HP-ICES offer significant potential for energy savings. Secondary benefits of HP-ICES include reduction of adverse environmental effects as compared to conventional systems, reliable production of services in contrast to the increasingly frequent utility curtailments and interruptions, and delivery of services to consumers at costs lower than those for conventional systems (including acquisition, operation, and maintenance costs). The objective of this multiphase project is development and demonstration of HP-ICES concepts leading to one or more operational systems by the end of 1984. The results of the system development phase of the HP-ICES Project are reported. Information is presented on: central heat pump and distributed heat pump ICES; potential applications; waste heat availability; system performance and economics; environmental impacts; site requirements; component testing requirements; mathematical analysis of heat balance and cost relations; and performance and economic

analyses of HP-ICES located near Seattle, Washington and San Antonio, Texas. (LCL)

10298 (BNL—51097) **Data base for district heating pipe system design.** Lesse, R.; Karkheck, J.; Serry, H.; Tessmer, R. (Brookhaven National Lab., Upton, NY (USA)). Aug 1979. Contract EY-76-C-02-0016. 11p. Dep. NTIS, PC A02/MF A01.

A methodology and data base for assigning installation costs and length requirements of hot water pipes for district heat service are described. These variables are the most important elements in the cost of the distribution system. The assignment technique is applicable to any city and reflects such factors as land use intensity, congestion of present underground service lines, and local labor rates and materials procurement costs.

10299 (COO—4531-6) **Beneficial utilization of waste heat from power plants in wastewater treatment systems.** Ni, S.N.; Obayashi, A.W. (Illinois Inst. of Tech., Chicago (USA)). Jun 1979. Contract EC-77-S-02-4531. 115p. Dep. NTIS, PC A06/MF A01.

A number of wastewater treatment processes were analyzed for possible benefit in using waste heat from co-located steam-electric power plants. Three levels of treatment standards were considered, ranging from secondary treatment to stricter tertiary requirements which involve nutrient removal. Three sizes of treatment plants were analyzed, ranging from those serving 33,000 to 2,000,000 population. The processes analyzed included activated sludge, trickling filter, rotating biological contactors and the Bardenpho process. In the study, a fraction of the condenser discharge was considered mixed with primary-treated wastewater, thereby accelerating the biological secondary-treatment processes at the expense of dilution. In each case, the most cost-effective fraction of condenser flow to be utilized was determined. After treatment, a portion of the mixture would be returned to the power plant in order to recycle the corresponding condenser discharge and provide the necessary evaporative makeup for the cooling system. The balance of the mixture would constitute the water product of the treatment plant. The benefit of waste heat used to replace fuel oil in sludge digesters was also analyzed. In the case of the lowest effluent standards (Group 1), the most cost-effective secondary treatment process was activated sludge without waste-heat recycle because it is dominated by non-thermal considerations. Group 2 standards were favored by rotating biological contactors with waste-heat recycle. The most advanced Group 3 standards were optimally met by the Bardenpho process, also with waste-heat recycle. In all cases, anaerobic sludge digestion with waste heat in place of fuel oil was most economical. The overall savings in levelized annual costs ranged from 1.5% for the smallest plants to 9.9% for the largest plants, by using waste heat optimally as compared with optimal systems without waste heat.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 9747, 9749, 9758, 9768, 9856, 10290, 10600

10300 (NTIS/PS—79/0826) **Solid waste reclamation and recycling. Part 1. Packaging and containers (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 113p. NTIS PC N01/MF N01.

The bibliography cites research reports on the following aspects of packaging, recycling, and reclamation: Management of civilian and military packaging wastes, pollution abatement, economics, handling, incinerator residues, and new materials and products from waste packaging. Only reports actually specifying packaging materials are included. See the other Published Searches of this series for studies on recycling of specific materials, such as glass, metals, plastics, and paper. Government policies, such as mandatory deposit legislation and tax incentives for recycling and waste reduction, are discussed. (This updated bibliography contains 105 abstracts, 5 of which are new entries to the previous edition.)

10301 (NTIS/PS—79/0827) **Solid waste reclamation and recycling. Part 2. Plastics (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 133p. NTIS PC N01/MF N01.

The recovery of waste plastics including that from packaging, tires, and urban refuse is covered. The sorting, decomposition to reusable chemicals, and reuse in new products are discussed along with the economics, legislation, policies, and planning aspects of plastics recycling. (This updated bibliography contains 125 abstracts, 10 of which are new entries to the previous edition.)

10302 (NTIS/PS—79/0828) **Solid waste reclamation and recycling. Part 3. Metals (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 296p. NTIS PC N01/MF N01.

Reports cited cover the following topics: Metal scrap refining and reuse, metal waste separation, the secondary metal industry, economic factors in metal recovery, junk car disposal, and metal recovery from urban refuse and industrial liquid waste streams. Studies on management planning, energy use, Government policies, and waste processing are also included. (This updated bibliography contains 294 abstracts, 19 of which are new entries to the previous edition.)

10303 (NTIS/PS—79/0829) **Solid waste reclamation and recycling. Part 4. Glass (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 124p. NTIS PC N01/MF N01.

Research on glass recovery from solid waste is cited. Waste glass sorting, handling, transportation, and reprocessing are covered. Studies on Government policies including mandatory bottle deposit laws and implementing recycling centers are included. The environmental, industrial, economic, and technical aspects of glass recycling are discussed. Examples of reuse in construction materials, fiberglass, bottles, and soil stabilization are presented. (This updated bibliography contains 116 abstracts, 9 of which are new entries to the previous edition.)

10304 (NTIS/PS—79/0830) **Solid waste reclamation and recycling. Part 5. Paper (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 156p. NTIS PC N01/MF N01.

Abstracts are presented on the reclamation and reuse of waste paper from municipal refuse, packaging, and newsprint. General planning, economics, legislation, and feasibility studies are included. Sorting equipment and techniques, reuse in construction materials, papermaking using recycled paper, pyrolysis to chemical compounds, and biodeterioration are covered. (This updated bibliography contains 148 abstracts, 6 of which are new entries to the previous edition.)

10305 (NTIS/PS—79/0831) **Solid waste reclamation and recycling. Part 6. Tires (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 42p. NTIS PC N01/MF N01.

Methods of processing scrap tires, such as shredding, shearing, radiation treatment, retreading, hydrogenation, extraction, and emulsifying are cited. Incentives for recycling are examined and markets for recycled products are discussed. The use of recycled tires in highways, embankments, construction materials, and other products is covered. (This updated bibliography contains 35 abstracts, 1 of which is a new entry to the previous edition.)

10306 (PB—294003) **Enhancement of municipal ferrous waste recycling through direct foundry application.** Gilmore, C.M.; Purcell, A.H.; Iman, M.A.; Kremer, A.F. (George Washington Univ., Washington, DC (USA). School of Engineering and Applied Science). Dec 1978. 24p. NTIS, PC A02/MF A01.

Charges of magnetically separated municipal ferrous waste (MFW) have been fed directly into a crucible foundry furnace mixed with varying fractions of stock and scrap cast iron. Mechanical testing of cast specimens with up to 50 weight percent MFW has revealed sound structures with strengths equal to those of standard cast specimens composed wholly of normal material. The recycled material from this experimental process appears to be useful for many cast iron applications. This research was performed at a working foundry using separated ferrous scrap from the National Center for Resource Recovery facility in Anacostia. The simplicity of the technology involved and its direct compatibility with established materials handling facilities indicates that such technology could be applied on small or large scales in a variety of waste recycling environments.

10307 **Firing and co-firing of processed urban refuse in utility operations.** Klumb, D.L. (Union Electric Co., St. I ouis, MO); Hollander, H.I. pp 193-205 of New fuels and advances in combustion technologies. Chicago, IL; Institute of Gas Technology (1979).

From New fuels and advances in combustion technologies symposium; New Orleans, LA, USA (26 Mar 1979).

Steam raising incinerators have been utilized for many years for disposing of as-discarded urban wastes which have now come to be regarded as an on-going local source of fuel. Processing urban wastes through shredding and separation of metals and glass, and firing the combustible fraction as a supplemental fuel in coal fired boilers is a recent innovation commencing in the early 1970's. While raw refuse may be regarded as a low grade fuel, when beneficiated it can become reasonably predictable in its physical and thermochemical properties and offers the opportunity to recover non-renewable material resources such as tin, steel, and aluminum, while significantly reducing dependence on ever diminishing availability of suitable, environmentally acceptable landfills. This paper describes the use of

processed solid waste as a prime or supplemental fuel for steam/power generation, some of the specific areas of concern, and the principal facilities in operation or under construction.

EDUCATION AND PUBLIC RELATIONS

10308 (DOE/IR/8685—01(Vol.2)) **Energy Education Materials Inventory.** (Houston Univ., TX (USA). Energy Inst.). Aug 1979. Contract EC-77-C-01-8685. 452p. Dep. NTIS, PC A20/MF A01.

The two volumes of the Energy Education Materials Inventory (EEMI) comprise an annotated bibliography of widely available energy education materials and reference sources. This systematic listing is designed to provide a source book which will facilitate access to these educational resources and hasten the inclusion of energy-focused learning experiences in kindergarten through grade twelve. EEMI Volume II expands Volume I and contains items that have become available since its completion in May, 1976. The inventory consists of three major parts. A core section entitled Media contains titles and descriptive information on educational materials, categorized according to medium. The other two major sections - Grade Level and Subject - are cross indexes of the items for which citations appear in the Media Section. These contain titles categorized according to grade level and subject and show the page numbers of the full citations. The general subject area covered includes the following: alternative energy sources (wood, fuel from organic wastes, geothermal energy, nuclear power, solar energy, tidal power, wind energy); energy conservation, consumption, and utilization; energy policy and legislation, environmental/social aspects of energy technology; and fossil fuels (coal, natural gas, petroleum). (RWR)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 10313

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 10235

10309 (ANL/OEPM—78-8) **Research, development and demonstration of lead-acid batteries for electric vehicle propulsion. Annual report, 1978.** (ESB, Inc., Yardley, PA (USA). ESB Technology Center). Oct 1979. Contract W-31-109-ENG-38. 106p. Dep. NTIS, PC A06/MF A01.

The goals of the present R and D effort are to completely design, evaluate and construct two levels of electric vehicle batteries - Improved State-of-the-Art and Advanced. Research progress is reported. (TFD)

10310 (ANL/OEPM—78-14) **Research, development and demonstration of nickel-iron batteries for electric vehicle propulsion. Annual report, 1978.** (Westinghouse Electric Corp., Pittsburgh, PA (USA)). Oct 1979. Contract W-31-109-ENG-38. 76p. Dep. NTIS, PC A05/MF A01.

The program has advanced to the level of full-size, prototype cell fabrication and evaluation. EPP nickel electrodes are now being prepared of up to 24 Ah/plate (at C/3 drain rate) at design thickness (2.5 mm). Iron electrodes of the composite-type are delivering 24 Ah/plate (at C/3) at target thickness (1.0 mm). Both plates are displaying good capacity stability at 130 to 175 test cycles, respectively, in some of the 3 plate cell tests. Finished cells are delivering up to 58 Wh/Kg at C/3, based on projected weight of the finished cell and in the actual designed cell volume. Reduction in cell resistance, reduction in nickel plate processing time and swelling on cycling are areas of major effort to reach the final battery objectives. Thermal nickel electrodes are showing promise in full size plate tests (up to 22 Ah in a plate of only 2.3 mm thickness) and will be evaluated in finished cells as soon as the technology shows repeatable results in full-size test plates.

HYBRID SYSTEMS

REFER ALSO TO CITATION(S) 10235

EMISSION CONTROL

REFER ALSO TO CITATION(S) 10267, 10268, 10269, 10270, 10271, 10272, 10273, 10274, 10275, 10276, 10277, 10278, 10279, 10280, 10281, 10282, 10283, 10284, 10285, 10286, 10287

10311 (AD-A—066556) **Exhaust emissions characteristics for a general aviation light-aircraft Avco Lycoming I0-360-A1B6D piston engine. Final report.** Becker, E.E. (National Aviation Facilities Experimental Center, Atlantic City, NJ (USA)). Feb 1979. 95p. NTIS, PC A05/MF A01.

The Avco Lycoming IO-360-A1B6D engine (S/N888-X) was tested at the National Aviation Facilities Experimental Center (NAFEC) to develop a steady state exhaust emissions data base. This data base consists of current production baseline emissions characteristics, lean-out emissions data, effects of leaning-out the fuel schedule on cylinder head temperatures, and data showing ambient effects on exhaust emissions and cylinder head temperatures. The engine operating with its current full-rich production fuel schedule could not meet the proposed Environmental Protection Agency (EPA) standard for carbon monoxide (CO) under sea level, standard day conditions. The engine did, however, meet the proposed EPA standards for unburned hydrocarbons (HC) and oxides of nitrogen (NOx) under the same sea level test conditions. The results of testing the engine under different ambient conditions (hot day) are also presented, and these results show a trend toward higher levels of emissions output for CO and HC while producing slightly lower levels of NOx.

10312 (AD-A—066589) **Exhaust emissions characteristics for a general aviation light-aircraft Avco Lycoming I0-360-B1BD piston engine. Final report.** Becker, E.E. (National Aviation Facilities Experimental Center, Atlantic City, NJ (USA)). Feb 1979. 91p. NTIS, PC A05/MF A01.

10313 (AD-A—070010) **Exhaust emissions characteristics for a general aviation light-aircraft Teledyne Continental Motors TSIO-360-C piston engine. Final report.** Becker, E.E. (National Aviation Facilities Experimental Center, Atlantic City, NJ (USA)). May 1979. 81p. NTIS PC A05/MF A01.

The Teledyne Continental Motors TSI0-360-C engine (S/N 300244) was tested at the National Aviation Facilities Experimental Center (NAFEC) to develop an exhaust emissions data base. This data base consists of current production baseline emissions characteristics, lean-out emissions data, effects of leaning-out the fuel schedule on cylinder head temperatures, and data showing ambient effects on exhaust emissions and cylinder head temperatures. The engine operating with its current full-rich production fuel schedule could not meet the proposed Environmental Protection Agency (EPA) standard for carbon monoxide (CO) and unburned hydrocarbons(HC) under sea level standard-day conditions. The engine did, however, meet the proposed EPA standard for oxides of nitrogen (NOx) under the same sea level conditions. The results of engine testing under different ambient conditions (essentially sea level standard day to sea level hot day) are also presented, and these results show a trend toward higher levels of emissions output for CO and HC while producing slightly lower levels of NOx.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 9628

MATERIALS

10314 (UCRL—50028-79-3) **H-Division quarterly report, July-September 1979.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1979. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

This report defines the objectives of groups in H Division of the LLL Physics Department and describes the status of projects underway: Theoretical EOS Group - anisotropic intermolecular potential of N_2, Grueneisen parameter for compressed Xe, high-temperature EOS of metallic solids, a node placement algorithm for piece-wise polynomials; Experimental Physics Group - properties of materials at high pressure, recent experiments at Janus; Fluid Physics Group - fluid mixture theory, the equation of state for the classical one-component plasma: improved Monte Carlo results and a theoretical derivation; Code Development/Applied Physics Group - water EOS and an investigation of underwater explosions, calculation of Cabriolet. Detailed individual reports on completed work may be expected. 24 figures, 3 tables. (RWR)

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 9562, 9564

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 10082, 10084, 10085, 10086, 10091

10315 (AD-A—070295) **Eddy current testing and ultrasonic reference standards for depleted uranium barstock. Final report.** Anderson, C.W. (Naval Surface Weapons Center, Dahlgren, VA (USA)). Mar 1979. 27p. NTIS PC A03/MF A01.

The design and testing of ultrasonic test standards for one-half inch (12.7mm) diameter depelted uranium barstock is discussed. This report also explores the feasibility of testing the barstock for near surface flaws using an eddy current technique. It is shown that eddy current testing is the most efficient means available for detecting surface and near surface flaws in the barstock material.

10316 Ultrasonic testing of austenitic welds by using controlled acoustic pulses. Crostack, H.A.; Steffens, H.D. (Dortmund Univ. (Germany, F.R.)). pp 231-236 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The ultrasonic testing of welded seams is often subject to an unfavourable signal/noise ratio caused by microstructural scattering. The application of a new transmitting concept which produces acoustic pulses of defined spectral composition offers an improvement in testability. The improvement achievable in defect detection is compared to the findings of conventional testing technique and discussed.

10317 Supersaturated substitutional alloys formed by ion implantation and pulsed laser annealing of group-III and group-V dopants in silicon. White, C.W.; Wilson, S.R.; Appleton, B.R.; Young, F.W. Jr. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **51**: No. 1, 738-749(Jan 1980).

The formation of supersaturated substitutional alloys by ion implantation and rapid liquid-phase-epitaxial regrowth induced by pulsed laser annealing has been studied using Rutherford backscattering, ion channeling analysis. Group-III (Ga, In) and group-V (As, Sb, Bi) dopants have been implanted into single-crystal silicon at doses ranging from 1×10^{15} to $1 \times 10^{17}/cm^2$. The samples were annealed with a Q-switched ruby laser (energy density ~ 1.5 J/cm^2, pulse duration $\sim 15 \times 10^{-9}$ sec). Ion channeling analysis shows that laser annealing incorporates these dopants into substitutional lattice sites at concentrations far in excess of the equilibrium solid solubility. Channeling measurements indicate the silicon crystal is essentially defect free after laser annealing. Also values for the maximum dopant concentration (C/sup max//sub s/) that can be incorporated into substitutional lattice sites are determined for our annealing conditions. Dopant profiles determined by Rutherford backscattering are compared to model calculations which incorporate both dopant diffusion in liquid silicon and a distribution coefficient from the liquid. It is necessary to assume an interfacial distribution coefficient (k') far greater than the equilibrium value k_0 to fit the experimental data. The relationship of C/sup max//sub s/ and k' to the formation of these supersaturated alloys is discussed.

10318 Electron beam welding of heavy sections - results of recently developed techniques. Hiller, W.; Steigerwald, K.H. (Steigerwald Strahltechnik G.m.b.H., Muenchen (Germany, F.R.)). pp 183-185 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Results are obtained with a 'mobile vacuum' EB welding unit and with techniques for automatic adjustment of the welding process to the conditions of the welding joint.

10319 Flow characteristic of high temperature brazing filler metals on nickel base. Iversen, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)); Lugscheider, E. (Technische Hochschule Aachen (Germany, F.R.)). pp 104-109 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Capillary flow characteristic of important high temperature brazing filler metals on nickel base. Dependence on brazing temperature and clearance. Significance for optimum quality of high-stress components. Applications of high temperature brazing in vacuum.

10320 Role of phase transformations in the development of residual stresses during the welding of some fast reactor steels. Jones, W.K.C.; Alberry, P.J. (Central Electricity Generating Board, Southampton (UK). Marchwood Engineering Labs.). pp 471-475 of Ferritic steels for fast reactor steam generators. Pugh, S.F.; Little, E.A. (UKAEA, Harwell. Atomic Energy Research Establishment) (eds.). London; British Nuclear Energy Society (1978).

From British Nuclear Energy Society conference on ferritic steels for fast reactor steam generators; London, UK (30 May 1977).

The manner in which residual stress is accumulated during a weld thermal cycle has been assessed for uniaxial specimens using a heat affected zone simulation technique. Preliminary studies have been carried out on a range of steels and 2CrMo, 9CrMo and AISI 316 which are candidate materials for CFR have been examined in detail. A quantitative model based on the measured variation in mechanical properties and transformation behaviour during a weld thermal cycle has been developed to describe the way in which residual stress develops during cooling. The principles involved in the model are generally applicable and can be incorporated in residual stress analyses so that practical methods of reducing the magnitude of the residual stress in complex thick section weldments can be examined.

10321 Development of US-testing technique for austenitic weldments. Just, T.; Kuhlow, B.; Matthies, K.; Neumann, E.; Roemer, M. (Technischer Ueberwachungs-Verein Norddeutschland e.V., Hamburg (Germany, F.R.)). pp 237-242 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Testing of coarse grained austenitic weldments using the transmitter-receiver technique and pressure waves. Advantages and limitations of this technique for the testing of specimens with plane and curved surfaces. Description of the efficiency of Ultrasonic testing of the basis of practical experiences in the workshop.

10322 Method for determining the deformation behaviour of the heat affected zone (HAZ). Krischke, D.; Schadel, O.; Schulze, H. (Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (Germany, F.R.)). pp 212-217 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The procedure consists in a combined mechanical/metallographical examination method. Since it allows a quantitative judgement of the deformation properties of micro structure areas, it also seams especially suitable for the HAZ examination of weldments.

10323 Selection of interlayers for solid state bonding of stainless steel with metals of groups IVa, Va and VIa. Lison, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). pp 189-193 of Schweissen in der Kerntechnik. Duesseldorf, Germany F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The results of the work performed showed the possibilities of producing bonds between a noble steel and metals of the groups IVa, Va and VIa. Metal interlayers must be used due to the different physical and metallurgical properties. Metallurgical laws can be used to select the intermediate metals. The joining method diffusion welding can be adapted to the fabrication of such compound bodies with metal interlayers. The work carried out do not include optimization of the necessary welding parameters.

10324 Investigations on nuclear materials weld cladded by the plasma hot wire process. Ruge, J.; Trarbach, K. (Technische Univ. Braunschweig (Germany, F.R.)). pp 52-59 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Fundamental examinations of one- and two layer PHA-weld claddings. Metallographical, mechanical-technological properties and corrosion resistance of pressure vessels steels 22 NiMoCr 3 7 and 20 MnMoNi 5 5, as well as cladding materials X 2 CrNiNb 19 9 and S NiCr 20 Nb.

10325 Submerged arc welding with hot wire addition. Wanke, R. (Messer Griesheim G.m.b.H., Unterschleissheim (Germany, F.R.)). pp 110-114 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Description of the process is given, the balance of energy performed. There are certain differences of metallurgical behaviour compared to other processes. With a joint weld the mechanical properties economic aspects are observed.

10326 Manufacture of an Inconel pressure vessel. Herz, H.; Iversen, K.; Stiefelhagen, B. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). pp 131-138 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The fabrication of a thermo-shock-loaded pressure vessel of high temperature nickel alloys required the individual licensing of the basic and addition materials according to the AD data sheets Contrary to the experience of Duennbleck processars, it was found that the alloy Inconel 718 in its hardened state could not be allowed due to the formation of the brittle raves phase in the welding deposit. Positive experience was acquired however with the non-hardenable alloy Inconel 625 which could be processed as jacket materials without problem. Rods of Inconel 625 were used as similar additive for WIG welding and the same type electrode 112 for E-welding. The heat resistance required of 320 N/cm^3 at 623°K and the lowest notch bar value of 35 J/cm^3 at RT were well surpassed. The mixed compounds of Inconel 625 and 718 were also no problem when welding with the non-hardening additives Inconel 625 and 112 and eliminating a thermal treatment.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 10322, 10920

10327 (BNL—27113) **Special about transition metals in alloy phase formation.** Watson, R.E.; Bennett, L.H. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 26p. (CONF-790219—13). Dep. NTIS, PC A03/MF A01.

From AIME annual meeting; New Orleans, LA, USA (18 Feb 1979).

The d-electrons are special, though their bonding properties remain to be completely understood. It is recognized that d band broadening is the dominant term contributing to transition metal cohesion. It is also generally recognized that in compound formation between transition-metals and polyvalent metals, hybridization between d-bands and polyvalent atom p bands provides a significant contribution to the energy (for example there is such a term in Miedema's scheme). Less generally realized is that d-band hybridization leads to changes in d-electron counts at a transition metal site which are opposite in sign to the net charge transfer on or off the site. The renormalized atom picture of cohesion of the pure transition metals and consider the experimental evidence and the theoretical understanding of d charge transfer going the wrong way are reviewed. A picture of the electronegativity of transition metals based on this trend is developed. Charge transfer associated with equalizing the local chemical potentials in alloys is estimated. Friedel type model alloy calculations are reviewed. The implications of the experimental charge transfer information from Moessbauer isomer shifts to such model alloy calculations and to the strength of the Coulomb enery associated with charge transfer is considered.

10328 (BNL—27114) **Parameters in semi-empirical theories of alloy phase formation.** Bennett, L.H.; Watson, R.E. (National Bureau of Standards, Washington, DC (USA); Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 35p. (CONF-790219—12). Dep. NTIS, PC A03/MF A01.

From AIME annual meeting; New Orleans, LA, USA (18 Feb 1979).

Many theories of alloy solubility, structural stability of compounds, and heats of formation in alloying rely on parameters such as valence, size or electronegativity for their predictions. Nature, of course, requires only one parameter, the nuclear charge to completely specify all the electronic properties of the elements. Thus, the atomic parameters are, of necessity, initimately connected with one another. This presentation reviews the physical origins of some of the more popular parameters used. The relaionship of the different electronegativity scales to each other, and the relationship of electronegativity to other parameters such as atomic size are emphasized. Structural stability maps employing electronegativity and some other parameters are shown for intermetallic compounds formed from different classes of elements: main group-main group, transition metal-main group, and transition metal-transition metal.

10329 (LBL—9047) **Mechanical properties and microstructures of dual phase steels containing silicon, aluminum and molybdenum.** O'Neill, T.J. Jr. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1979. Contract W-7405-ENG-48. 107p. Dep. NTIS, PC A06/MF A01.

Thesis.

An investigation concerning the heat treatment of duplex ferritic-martensitic low carbon steels containing silicon, aluminum and molybdenum was carried out. Tensile properties of intermediately quenched and directly annealed specimens were characterized and microstructural correlations established. The two-phase mixture rule is used as a fairly good approximation of the mechanical behavior of the duplex system, but it has been recognized that the properties of both the ferrite and martensite depend on the volume fraction of martensite produced in the final morphology. Thus, although the volume fraction of martensite appears to be the most influentuial factor in controlling the behavior of the duplex steel, ferrite strengthening may occur by precipitation hardening, and the strength of martensite may increase due to carbon enrichment as its volume fraction is decreased. Utilization of both of these factors results in a composite whose properties do not depend upon the martensite volume fraction (up to about .4). Greater leeway can be achieved in controlling the heat treatment temperatures of the alloy. Such a steel, a Fe/.06C/.93A1 alloy, has been investigated in this study.

10330 Self-consistent field model for condensed matter. Liberman, D.A. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 4981-4989(15 Dec 1979).

A model for condensed matter is described in which the ions surrounding a particular atom are replaced by a positive charge distribution which is constant outside of a sphere containing the atom and zero inside. The orbital functions, both bound and free, are obtained as solutions of the Dirac equation and are used to self-consistently determine the potential function. In order to obtain the desired equation-of-state data from the calculations, three different and somewhat arbitrary prescriptions are used to separate quantities pertaining to the atom from those of the electron gas in which it is imbedded. Results are shown for 14 elements, including the 5d transition metals, in the neighborhood of normal solid density. Equation-of-state data for nickel, copper, and zinc are also given and are compared with experiment.

10331 Neutron-scattering measurements of phonon perturbations in irradiated copper. Nicklow, R.M.; Crummett, W.P.; Williams, J.M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 5034-5043(15 Dec 1979).

Neutron-scattering measurements have been carried out on the transverse phonons with wave vectors q= (0,0,zeta)2π/a for 0.04 < or = zeta < or = 0.20 in a copper single crystal which had been irradiated at 4.2 K to give a Frenkel-defect concentration of approximately 1.3 x 10^{-4}. The measurements were obtained at 4.2 K after the irradiation and after annealing the sample at 72, 300, 450, and 800 K. The data for the as-irradiated sample show defect-phonon perturbation effects which are similar to those observed in a previous preliminary investigation, carried out on a sample with a defect concentration of 0.4 x 10^{-4}. The phonon peak shapes possess unusual structure consisting of a narrow component which displays a resonantlike zeta-dependent frequency shift and an additional component for zeta < or = 0.07 which appears only on the high-frequency side. An anneal at 72 K removes the resonant frequency shift but only little of the additional high-frequency structure. This structure is still clearly visible for zeta < or = 0.05 after an anneal at 300 K, but it appears to be removed by the 800 K anneal. The results cannot be explained entirely by simple model calculations for the <100> split interstitial.

10332 Theory of the hydrogen interstitial impurity in germanium. Pickett, W.E.; Cohen, M.L.; Kittel, C. (Department of Physics, University of California, Berkeley, California 94720). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 5050-5058(15 Dec 1979).

The self-consistent pseudopotential method is used to study the electronic structure of the hydrogen interstitial impurity in Ge. The impurity is considered to be at the site of tetrahedral symmetry and strong intra-atomic correlation effects are included. It is found that a singly occupied H-1s deep donor state exists, a result consistent with positive muon spin rotation (μ^+SR) experiments. This state lies at least 1 eV, and perhaps as much as 6 eV, below the Ge valence-band maximum. An examination of the charge density suggests only a small tendency of H to bond with the neighboring Ge atoms. It is tentatively concluded that this deep donor state is the one probed by μ^+SR experiments but that H migrates to impurity- or defect-related complexes or forms of molecular hydrogen rather than remaining as an isolated interstitial impurity.

10333 Numerical study of cavity growth controlled by surface diffusion. Pharr, G.M.; Nix, W.D. (Stanford Univ., CA). *Acta Metall.;* **27**: No. 10, 1615-1631(Oct 1979).

The growth of grain boundary cavities is examined using a finite difference numerical scheme. The mechanism studied is that proposed by Chuang and Rice in which atoms are driven by gradients in curvature along the surface of the cavity to the grain boundary. Atomic transport in the grain boundary is assumed to be fast compared to that along the cavity surface. The shape evolution of an intially lenticular cavity is followed in detail and in this respect the treatment differs from the Chuang-Rice approach in which a steady-state crack-like configuration is assumed. This allows examination of the effects of capillarity and transients on the growth

process. For an isolated cavity on an infinite boundary, it is found that the Chuang-Rice treatment accurately describes cavity growth once the steady state is achieved. The effect of capillarity is manifested by an incubation period during which a nose protrudes from the tip of the cavity. It is the nose of the cavity that behaves like the Chuang-Rice steady-state crack. An array of cavities is also studied to determine the effects of cavity interaction on the growth process. The results of this investigation compare favorably with rupture data for silver containing implanted grain boundary water vapor bubbles.

10334 μSR in imperfect solids. Huang, C.Y. (Los Alamos Scientific Lab., NM (USA)); Huber, D.L. (Wisconsin Univ., Madison (USA). Dept. of Physics). *Hyperfine Interact.;* **6**: No. 1-4, 335-339(Jan-Feb 1979).

From 1. international topical meeting on muon spin rotation; Rorschach, Switzerland (4 - 7 Sep 1978).

The use of μ^+SR as a probe of point defects in metals is discussed. The importance of separating the effects due to the presence of the muon from those intrinsic to the defect-host system is stressed. It is suggested that studies of magnetic impurities in nonmagnetic hosts may yield data which are relatively probe-independent. A theoretical analysis of the depolarization of muons coupled to magnetic impurities is outlined. It is pointed out that measurements of the field dependence of the depolarization rate can give information about impurity spin correlation times.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 9591, 10071, 10316, 10322, 10329, 10372, 10373, 10374, 10500

10335 (BNL—26989) Analysis of critical current-bend strain relationships in composite Nb_3Sn superconducting wires. Luhman, T.; Welch, D.O. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 5p. (CONF-791102—86). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

In order to be used successfully in fusion magnets, Nb_3Sn conductors must meet several mechanical strain criteria, including tolerance to bending strains encountered during magnet construction. Since Nb_3Sn is extremely brittle much information has been generated regarding the sensitivity of these conductros to tensile strain. A recent comparison of critical current-bend and tensile test data indicates that the strain required to initiate compound cracking during bending is significantly less than the strain required to do so by tensile of critical current on bending strains in monofilamentary Nb_3Sn wires is calculated and compared with experimental data. The calculation takes into account a shift in the composite's neutral axis which occurs during bending. The analysis correctly predicts the observed depdndence of the critical current on bending strains.

10336 (LA—8127-MS) Defect formation in 800-MeV proton-irradiated aluminum. Jang, H.; Moteff, J.; Levinson, L.; Brown, R.D.; Green, W.V. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 15p. Dep. NTIS, PC A02/MF A01.

Transmission electron microscopy was used to investigate the formation of irradiation-induced defects in proton-irradiated high-purity aluminum. The specimens were irradiated by 800-MeV protons to about 0.25 displacements per atom (dpa) in the Los Alamos Meson Physics Facility (LAMPF), producing about 20 atomic ppM helium, 130 atomic ppM hydrogen, and approximately 70 atomic ppM of spallation products. The as-irradiated microstructure mainly consisted of cavities with a mean size of 88 A, number density of 1 x 10^{15} cavities/cm^3, and volume fraction of about 0.05%. The swelling was comparable to that of high-purity aluminum samples neutron-irradiated to the same displacement level. However, the high production rate of gas atoms during the proton irradiation increased the cavity number density by an order of magnitude relative to neutron irradiation, and reduced the cavity size by a factor of about 3. A postirradiation annealing treatment at 250°C resulted in complete disappearance of the small cavities and formaion of gas bubbles on grain boundaries.

10337 (ORNL—5540) High-temperature structural design program semiannual progress report for period ending December 31, 1978. Corum, J.M.; Pugh, C.E. (Oak Ridge National Lab., TN (USA)). Oct 1979. Contract W-7405-ENG-26. 320p. AT.

Progress is summarized in the ORNL High-Temperature Structural design program concerning constitutive equations for inelastic design analysis, inelastic structural tests and analyses, design criteria and rules for time-dependent deformation and failure, simplified design methods, thermal ratcheting tests, and structural design methods and weldments for LMFBR and other reactor system components that operate in the creep range. (FS)

10338 Elastic-constant variability in stainless-steel 304. Ledbetter, H.M.; Frederick, N.V.; Austin, M.W. (Fracture and Deformation Division, National Bureau of Standards, Boulder, Colorado 80303). *J. Appl. Phys.;* **51**: No. 1, 305-309(Jan 1980).

Variability of elastic constants in stainless-steel 304 was determined by measuring longitudinal and transverse ultrasonic velocities in 20 samples acquired randomly. Three kinds of variations: sample to sample, directional within a sample, and repeated measurements on a single sample: are reported for four elastic constants: the bulk modulus, Young's modulus, shear modulus, and Poisson's ratio. Because of surprisingly small variations, 1% or less, the principal problem became measurement sensitivity and reproducibility. To overcome this problem, a high-resolution measurement system was devised using general-purpose equipment augmented with a very simple impedance-transforming amplifier and an FET transmission gate. With this system the often-reported troublesome transit-time correction disappeared. Effects due to frequency and directionality were negligible.

10339 Theoretical descriptions of climb controlled steady state creep at high and intermediate temperatures. Spingarn, J.R.; Barnett, D.M.; Nix, W.D. (Stanford Univ., CA). *Acta Metall.;* **27**: No. 9, 1549-1561(Sep 1979).

Steady state creep via diffusion controlled dislocation climb is examined with particular reference to the role of dislocation core self diffusion. Several models for steady state creep controlled by dislocation climb lead to a creep equation where β varies from 1 to 10 and A is about 10. Two new models which account for the effect of dislocation curvature on the climb motion of the dislocation are introduced. They also lead to the above creep equation. These models and the resulting creep equation provide a basis for an effective diffusivity to be used in cases where both lattice and core self diffusion are involved. However, a review of the available creep data for pure metals at high and intermediate temperatures shows that the effective diffusivity concept is not fully consistent with experiment. Discrepancies between the above creep equation and existing data suggest that current theoretical descriptions are still incomplete.

10340 Hydrogen influenced cold cracking tendency of two high strength low alloy steels - evaluated by the implant-test. Neumann, V.; Schoenherr, W. (Bundesanstalt fuer Materialpruefung, Berlin (Germany, F.R.)). pp 217-223 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

A possible way of evaluating the hydrogen influenced cold cracking tendency of constructional steels is the implant test. Using this testing method, it is possible to adjust extensively independently of one other the three influencing parameters - hydrogen content of the welding deposit and the heat-affected zone, hardness structure and stresses - and to examine their effect on the crack behaviour. Due to the same microstructure formation in the heat affected zone of the implant samples and in the non-heat affected regions from the consequent position of the heat affected zone of component seams, welding conditions can be determined with suitable changing of the sample whose application to the real component practically excludes the danger of cold cracking. The broken surfaces in cold cracking are partly ductile and poor in deformation. The deformation-poor fracturing can possibly take an intercrystalline or transcrystalline course according to the chemical composition of the steel. The investigation confirm the theories and test results of other authors: The formation of deformation-poor, typical fracture sections for cold cracking was only obtained when there was a clear delay between putting on the test load and fracture of the sample.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 10334, 10372, 10380, 10499

10341 (BNL—2[illegible]950) Effects of differential thermal contraction between the matrix and the filaments in mono- and multifilamentary Nb_3Sn on the superconducting critical temperature. Aihara, K.; Suenage, M.; Luhman, T. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 6p. (CONF-791102—83). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The strain on Nb_3Sn due to the differential thermal contraction between the matrix (Cu, bronze) and the filaments (Nb, Nb_3Sn, Ta) of a superconducting wire is known to decrease the superconducting critical temperature T/sub c/. In order to study the effects of heat treatment conditions and filament size on the degradation of T/sub c/ by the strain. T/sub c/ for monofilamentary wires [(Nb_3Sn and bronze in Ta) in Cu matrix, and (bronze in Nb tubings) in Cu matrix] were measured for heat-treating periods in of 1 to 120 h at 725°C. Several observations were made regarding the effects on T/

sub c/ of thermal contraction strains from various components of the conductors. The influence of a Cu matrix on T/sub c/ was small (~ 0.2 K). When the bronze matrix was inside Nb tubing the degradation of T/sub c/ due to strains was substantially larger than when the Nb filaments were in a bronze. Wires with smaller filament diameters achieved a maximum T/sub c/ in shorter heat treatment times than those with larger filaments. These results are discussed in terms of the critical currents of these wires under applied tensile strains.

10342 (LA-UR—79-3509) **Planar streak camera laser-driven shockwave studies.** Veeser, L.R.; Lieber, A.J.; Solem, J.C. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-791220—3). Dep. NTIS, PC A02/MF A01.

From International conference on lasers '79; Orlando, FL, USA (17 Dec 1979).

High pressure equation-of-state parameter determination is now possible using a high-energy laser to drive shock waves into a multiple foil target. Recent progress in the design of streak cameras and targets has reduced the errors and uncertainties in impedance-match measurements to about 5 to 10%, and further improvements are expected in the near future. Initial measurements are reported for pressures in the few-megabar region for gold and aluminum.

10343 Effects of bending on the superconducting critical current density of monofilamentary Nb_3Sn wires. Kaiho, K.; Luhman, T.S.; Suenaga, M.; Sampson, W.B. (Metallurgy and Materials Science Division, Brookhaven National Laboratory, Upton, New York 11973). *Appl. Phys. Lett.;* **36**: No. 3, 223-225(1 Feb 1980).

Variations in the superconducting current density J/sub c/ of the Nb_3Sn wires upon bending were measured for a series of monofilamentary wires in which the ratio R/sub v/ of the matrix (Cu+Sn) to the core (Nb_3Sn,Nb) was changed from 0 to 58. In most cases J/sub c/ was found to increase slightly until the bending strain exceeded a value of ϵ/sup irr//sub B/ , beyond which it severely and irreversibly degraded. For wires with intermediate values of R/sub v/ (~2 to 10), ϵ/sup irr//sub B/ , calculated by geometrical considerations, was substantially lower than the measured value of the tensile strain ϵ/sup irr//sub T/ which was required to irreversibly degrade the critical current. The influence of bending strains on J/sub c/ can qualitatively be described by considering residual prestrains in the matrix and the core.

10344 Magnetic correlations and crystal-field levels in the superconductor (Ce/sub 0.73/Ho/sub 0.27/)Ru_2. Lynn, J.W.; Moncton, D.E.; Passell, L.; Thomlinson, W. (Department of Physics, University of Maryland, College Park, Maryland 20742). EY-76-C-02-0016. *Phys. Rev., B: Condens. Matter;* **21**: No. 1, 70-78(1 Jan 1980).

Neutron scattering studies have been carried out to investigate the atomic magnetic properties of the "magnetic" superconductor (Ce/sub 0.73/Ho/sub 0.27/)Ru_2. At low temperatures we observe the appearance of elastic or quasielastic magnetic scattering at small momentum transfers, indicating the development of ferromagnetic correlations. The temperature and wave-vector dependence of this scattering can be described to a good approximation by an Ornstein–Zernike correlation function over the entire range of wave vectors (0.035— 0.20 A^{-1}) and temperatures (0.05— 4.2 K) explored. The range of the spatial correlations ξ ($=1/\kappa$) increases smoothly with decreasing temperature and suggests the onset of ferromagnetism at ~0.5 K. However, below 0.5 K, ξ ceases to increase, saturating at a value of 80 A with no detectable change in the scattering below that temperature. Thus there is no transition to conventional long-range ferromagnetic order. There is also no indication in the magnetic scattering of the onset of superconductivity at 1.6 K. Measurements of the inelastic magnetic scattering reveal a number of crystal-field transitions, demonstrating that the crystalline electric field removes the 17-fold degeneracy of the J=8 Ho^{3+} free ion. The nature of the splittings can be understood on the basis of a crystal field with cubic symmetry, and the ground state is found to be the triply degenerate Γ_5 state, which possesses a magnetic moment. At low temperatures additional magnetic inelastic scattering is observed at low energies; this suggests that there are substantial exchange effects even though the characteristic magnetic temperature (0.5 K) is very small.

10345 Spontaneous magnetic order in Ce/sub 0.73/Ho/sub 0.27/Ru_2 below the superconducting transition temperature. Willis, J.O.; Erickson, D.J.; Olsen, C.E.; Taylor, R.D. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., B: Condens. Matter;* **21**: No. 1, 79-85(1 Jan 1980).

Moessbauer effect studies on the Laves-phase alloy Ce/sub 0.73/Ho/sub 0.27/Ru_2 have been carried out as a function of temperature to investigate the possible xoexistence of spontaneous magnetic order and superconductivity. The alloy was dilutely doped with ^{57}Co, which substitutes for the ruthenium atoms. At a temperature of about 2 K, the ^{57}Fe Moessbauer spectra showed the onset of line broadening that increased with decreasing temperature. The broadening is attributed to magnetic ordering of the holmium atoms, which produces magnetic interactions at some of the ^{57}Fe impurity nuclei, and is interpreted in terms of a model which yields temperature-dependent hyperfine fields H/sub i/. Saturation of H/sub i/ is suggested below 0.5 K. A molecular field model was fit to H/sub i/, giving a saturation hyperfine field of 3.47 +- 0.13 T and a magnetic ordering temperature of 1.72 +- 0.03 K. Low-field-susceptibility measurements determined the superconducting transition temperature to be 1.57 K with a half width of 0.18 K. The paramagnetic data were extrapolated to a Curie temperature of 1.3 +- 0.2 K. There is no evidence for reentrant behavior down to 35 mK. Magnetization measurements gave a magnetic moment of 5.080.2 μ/sub B/ per formula unit, and the derived high field susceptibility data gave a Curie temperature of 1.50.7 K. The reported results are consistent with the recent neutron—scattering measurements on Ce/sub 0.73/Ho/sub 0.27/Ru_2. The coexistence of superconductivity with some type of short-range ferromagnetism is supported.

10346 Equilibrium properties of the fluxoid lattice in single-crystal niobium. I. Magnetization measurements. Kerchner, H.R.; Christen, D.K.; Sekula, S.T. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 1, 86-101(1 Jan 1980).

The field derivative of the superconducting magnetization (dM/dH/sub a/) of a single-crystal niobium sphere was measured with the applied magnetic field parallel to the three high-symmetry crystal axes. A field-sweep technique was used to make direct, continuous measurements of dM/dH/sub a/, and the data were numerically integrated to obtain the magnetization M. Excellent magnetic reversibility indicates the attainment of equilibrium conditions. The Meissner state, the intermediate mixed state, the mixed state, and the normal state show up as distinct field regions of the dM/dH/sub a/ vs H/sub a/ plots separated by discontinuities in dM/dH/sub a/. The results are compared with microscopic theory and with related experimental studies of niobium. The magnetization measurements are compared directly with small-angle neutron-diffraction measurements of the fluxoid lattice in the same sample reported in the following paper.

10347 Equilibrium properties of the fluxoid lattice in single-crystal niobium. II. Small-angle neutron-diffraction measurements. Christen, D.K.; Kerchner, H.R.; Sekula, S.T.; Thorel, P. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **21**: No. 1, 102-117(1 Jan 1980).

A small-angle neutron-diffraction technique has been used to measure several properties of the flux-line lattice (FLL) in a single-crystal sphere of pure niobium. For applied fields parallel to several crystallographic directions in the (100) and (110) planes, the low-field mixed state and intermediate mixed state were investigated. From these results, the orientation dependence of the low-field critical parameters H/sub c/1 and B_0 are deduced. The consistency of these results is verified by comparison with direct measurements of the equilibrium misalignment angle between the applied-field direction and the fluxoid axes. In addition, results are reported which extend the available information concerning correlations between the FLL and crystal lattice (CL) symmetry properties.

10348 Neutron-scattering measurements of the generalized susceptibility chi (q,E) for Ni. Mook, H.A.; Tocchetti, D. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev. Lett.;* **43**: No. 27, 2029-2032(31 Dec 1979).

Neutron-scattering measurements have been performed on nickel to obtain more information about chi (q,E), the generalized susceptibility. Evidence of an optical mode that crosses the main [100] spin-wave branch was found in agreement with predictions based on the itinerant-electron band-theory approach. No optical mode was found for the [111] direction; however, the dispersion curve is found to deviate from a quadratic dispersion law.

10349 Bonding of oxygen on Al(111): A surface extended x-ray absorption fine-structure study. Johansson, L.I.; Stoehr, J. (Stanford Synchrotron Radiation Laboratory, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **43**: No. 25, 1882-1885(17 Dec 1979).

The initial ordered chemisorption stage of oxygen on Al(111) has been investigated using polarization-dependent surface extended x-ray absorption fine-structure measurements above the O K absorption edge. The O-Al bond length in the threefold hollow adsorption site has been determined to be 1.79 +- 0.05 A. A strong polarization dependence of the extended x-ray absorption fine-structure signal allows the determination of the O-O distance (2.90 +- 0.05 A) between the chemisorbed oxygen atoms.

10350 Superconductivity and the metal-nonmetal transition in Hg-Xe films. Epstein, K.; Dahlberg, E.D.; Goldman, A.M. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). EY-76-5-02-1569-A002. *Phys. Rev. Lett.;* **43**: No. 25, 1889-1892(17 Dec 1979).

The electrical conductivities and transition temperatures of films consisting of random mixtures of Hg and Xe condensed onto

substrates held at 4.2 K have been measured. A metal-nonmetal transition in which the temperature coefficient of resistance changes from positive to negative has been found near a volume fraction close to that expected for random percolation. This transition is accompanied by a substantial drop in the superconducting transition temperature which is measured resistively.

10351 Quantitative analysis of low-energy-electron diffraction: Application to Pt(111). Adams, D.L.; Nielsen, H.B.; Van Hove, M.A. (Institute of Physics, University of Aarhus, DK-8000 Aarhus C, Denmark). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 4789-4806(15 Dec 1979).

A method is described for quantitative analysis of low-energy-electron diffraction (LEED) intensity-energy spectra by comparison of experimental spectra with spectra calculated using a dynamic theory of LEED. The method involves a minimization of the variance of the fit between experimental and calculated spectra as a function of the calculational variables, both structural and nonstructural, leading to determination of optimum parameter values. Correlation between the variables is taken into account. The method is applied to extensive, new experimental LEED data for Pt(111). It is shown quantitatively that the variance of the fit depends strongly on the value of a single structural variable, d/sub perpendicular/, the first interlayer spacing, but weakly on the values of three nonstructural variables, V_0, the inner potential, V/sub im/, the absorption potential, and Θ/sub D/, the Debye temperature. The analysis leads to an optimum value of d/sub perpendicular/=2.29 A, corresponding to a 1% expansion of the first layer spacing, with an estimated error of +- 0.1 A. This result is in good agreement with the earlier studies of Kesmodel and co-workers.

10352 Self-consistent electronic structure of a transition-metal surface with an adsorbate:H on Mo(001). Kerker, G.P.; Yin, M.T.; Cohen, M.L. (Max-Planck-Institut fuer Festkoerperforschung, 7 Stuttgart 80, West Germany). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 4940-4947(15 Dec 1979).

The self-consistent pseudopotential method is applied to calculate the electronic structure of an ideal Mo(001) surface which is covered by a saturated monolayer of hydrogen. The calculation is performed for two values of d, the hydrogen-substrate interlayer distance. For d=0.75 A, the work function is identical to the experimental value of 4.9 eV. For d=0, the work function is shown to be smaller by 50%. The effect of saturated hydrogen chemisorption on the electronic structure of the surface results in two adsorbate-induced bands which lie below the substrate bulk bands. Most of the intrinsic surface states of the clean substrate continue to exist at the hydrogen-covered surface but at slightly lower energies. Recent angular-resolved photoemission data give some support to these results.

10353 Local-structure determination at high dilution: Internal oxidation of 75-ppm Fe in Cu. Hastings, J.B.; Eisenberger, P.; Lengeler, B.; Perlman, M.L. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **43**: No. 24, 1807-1810(10 Dec 1979).

The local atomic environment around the iron site was measured in reduced and in oxidized dilute alloys of Fe in Cu. For these measurements a new detector was employed that extends applicability of the EXAFS technique to systems 100 fold more highly dilute than those heretofore accessible. Details of the alloy study and implications for other research of the high sensitivity of this detector system are discussed.

10354 Multiple-q magnetic structure in $CeAl_2$. Shapiro, S.M.; Gurewitz, E.; Parks, R.D.; Kupferberg, L.C. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Phys. Rev. Lett.;* **43**: No. 23, 1748-1751(3 Dec 1979).

New neutron diffraction measurements on single crystals of $CeAl_2$ confirm the previously reported incommensurate antiferromagnetic ground state with peaks at $q_1 = (1/2 +- \alpha, 1/2$ minus-or-plus $\alpha, 1/2)$. In addition, weaker superlattice peaks are observed at q/sub c/= (1/2,1/2,1/2) and their position and temperature dependence can be explained in terms of a multiple-q structure in $CeAl_2$. This appears to be the first definitive evidence for a multi-q magnetic structure.

10355 Effects of pressure on the structural and superconducting properties of Nb_3As, Nb_3Si, Nb_3Ge, and Nb/sub 0.82/Ge/sub 0.18/. Skelton, E.F.; Gubser, D.U.; Willis, J.O.; Hein, R.A.; Yu, S.C.; Spain, I.L.; Waterstrat, R.M.; Sweedler, A.R. (Naval Research Laboratory, Washington, DC 20375). *Phys. Rev., B: Condens. Matter;* **20**: No. 11, 4538-4543(1 Dec 1979).

The effects of pressure on both the structure and superconducting transition temperatures (T/sub c/) of several Nb-based compounds are examined. Comparisons are made between the Ti_3P-structure type, in which Nb_3As and Nb_3Si normally crystallize, and the A-15 structure in which Nb_3Ge and many other high-T/sub c/ materials form. A comparison is also made between stoichiometric and nonstoichiometric forms of the A-15 structure. The compressibilities are measured under hydrostatic pressures to about 6 GPa; the pressure dependences of T/sub c/ are measured to about 10 GPa for the As and Si compounds and to about 1 GPa for the Ge compounds. The structural and electrical measurements are combined and the volume dependences of T/sub c/ are reported and compared. Considerations are given to the possibility of a pressure-induced transition from the Ti_3P type to the A-15 structure for the As and Si compounds.

10356 Instantaneous flux-change measurement of the mobile dislocation density in crystals. Pang, C.S.; Galligan, J.M. (Department of Metallurgy and Institute of Materials Science, University of Connecticut, Storrs, Connecticut 06268). *Phys. Rev. Lett.;* **43**: No. 21, 1595-1598(19 Nov 1979).

This Letter presents measurements of the mobile dislocation density in lead—5%-indium crystals, in which we measure the change in flux accompanying the motion of dislocations. In particular, we show that the present technique allows us to establish how the mobile dislocation density varies for crystals undergoing vastly different types of work hardening. In addition, we use the present technique to show how the mobile dislocation density varies with applied strain rate.

10357 Special phonons and superconductivity in the hexagonal tungsten bronzes. Kamitakahara, W.A.; Scharnberg, K.; Shanks, H.R. (Ames Laboratory—United States Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50011). W-7405-ENG-82. *Phys. Rev. Lett.;* **43**: No. 21, 1607-1611(19 Nov 1979).

Neutron scattering measurements on single crystals of hexagonal tungsten bronzes M/sub 0.33/WO_3 reveal low-frequency, relatively dispersionless phonon branches which can be associated with the vibrations of the metal atoms M in the large open channels they occupy in the crystal structure. An analysis based on Eliashberg theory shows that the strong dependence of the superconducting transition temperature on the species M arises from these special phonons.

10358 Chemical mechanisms of Schottky barrier formation. Brillson, L.J. (Xerox Webster Research Center, Webster, New York 14580). *J. Vac. Sci. Technol.;* **16**: No. 5, 1137-1142(Sep 1979).

Ultrahigh vacuum studies of reactive and unreactive metals on a wide range of semiconductors reveal new systematics of Schottky barrier formation. Surface work function, band bending, and chemical bonding measurements indicate several qualitatively different mechanisms of barrier formation, each determined by the degree of interface chemical reactivity. In general, the Schottky barrier formation can be characterized by a twofold process: local charge redistribution plus surface space charge transfer. The specific interface bonding determines the sign and magnitude of the local charge redistribution. Correlations between these interface phenomena and deviations from ideal barrier heights suggest a framework based on interface bonding for determining Schottky barrier heights.

10359 Surface EXAFS investigation of oxygen chemisorption on GaAs(110). Stoehr, J.; Bauer, R.S.; McMenamin, J.C.; Johansson, L.I.; Brennan, S. (Stanford Synchrotron Radiation Laboratory, Stanford University, Stanford, California 94305). *J. Vac. Sci. Technol.;* **16**: No. 5, 1195-1199(Sep 1979).

Surface extended x-ray absorption fine structure measurements (EXAFS) are reported for the initial oxidation stage of the GaAs(110) surface which is characterized by a +2.9 eV binding energy shift of the As 3d photoemission peak. The surface EXAFS measurements employed a variation of the previously used secondary-electron-collection technique which significantly increased the surface sensitivity. We find oxygen to be chemisorbed in atomic form. The importance of using phaseshifts derived from model systems rather than using theoretically calculated phaseshifts for distance determinations from low Z atoms is pointed out.

10360 Comparative studies of oxygen adsorption on GaAs(110) surfaces with ultrathin aluminum and cesium overlayers. Skeath, P.; Su, C.Y.; Chye, P.W.; Pianetta, P.; Lindau, I.; Spicer, W.E. (Stanford Electronics Laboratories, Stanford University, Palo Alto, California 94305). *J. Vac. Sci. Technol.;* **16**: No. 5, 1439-1442(Sep 1979).

The oxidation of GaAs(110) surfaces is found to be profoundly influenced by the deposition of very thin metal overlayers. However, the Fermi energy pinning at the interfaces is only slightly influenced by the oxidation of the metal overlayer and semiconductor. Aluminum and cesium covered surfaces are investigated using soft x rays (SXPS). Oxygen uptake by the Al and Cs overlayers is much more rapid than by the bare GaAs surface. Oxidation of the GaAs through the Al overlayer occurs more slowly than for the bare surface. In strong contrast to the aluminized surface, oxygen was found to bond to surface As atoms on the cesiated surface with 10^6 times faster uptake compared to the bare surface. These results are important in the context of GaAs passivation, Schottky barriers, negative electron affinity (NEA) photocathodes, and metal oxidation processes.

10361 Electronic structure in GaAs/Ge through angle-resolved photoemission. Denley, D.; Mills, K.A.; Perfetti, P.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). *J. Vac. Sci. Technol.;* **16**: No. 5, 1501-1503(Sep 1979).

We present preliminary results of experiments detailing the changes in the valence band electronic structure of GaAs upon the submonolayer evaporative deposition of Ge. Measurements for electron wavevectors along the Gamma-barX-bar and Gamma-barX-bar' directions in the surface Brillouin zone show a loss of photocurrent from states in the valence band edge and the growth of sharp features. These features are found (1) near but within the calculated valence band edge (~1.4 eV, Gamma-barX-bar direction; ~1.2 eV, Gamma-barX-bar') (2) midband (~3.2 eV, Gamma-barX-bar; ~4.2 eV, Gamma-barX-bar'), (3) in and near the projected gap (~4.1 eV, Gamma-barX-bar; ~ 2.5 eV, Gamma-barX-bar'), and (4) in the ionic gap (~7.1 eV). In addition, a new deeply bound (13 eV) GaAs surface state is observed.

10362 Carrier transport coefficients across GaAs—GaAlAs (100) interfaces. Osbourn, G.C.; Smith, D.L. (California Institute of Technology, Pasadena, California 91125). *J. Vac. Sci. Technol.;* **16**: No. 5, 1529-1532(Sep 1979).

We present calculations of reflection and transmission coefficients for electrons and holes at (100) interfaces for the GaAs—Ga/sub 1en-dashx/Al/sub x/As system. We consider semi-infinite crystals of the two semiconductors joined at an abrupt or compositionally graded interface. The calculations are performed using the empirical tight binding approximation. The transport coefficients were computed as a function of the components of the incident carrier wavevector normal and parallel to the interface. We have investigated the transport coefficients for incident states near various band minima into different final state channels. The transmission into states with qualitatively similar character to the incident state is found to be much greater than transmission into states of different character. For example, an electron near the X minimum normal to the interface in Ga/sub 1en-dashx/Al/sub x/As transmits into the X valley of GaAs with much greater probability than it transmits into the Γ minimum of GaAs. We have investigated the dependence of the transport coefficients on alloy composition. The effect of compositional grading of the interface on the transport coefficients has also been investigated.

10363 Specific heat of two cubic Laves compounds: $TiBe_2$ and $ThMg_2$. Stewart, G.R. (Los Alamos Scientific Lab., NM (USA)); Matthias, B.T.; Giorgi, A.L.; Szklarz, E.G.; Smith, J.L. *Solid State Commun.;* **30**: No. 11, 709-711(Jun 1979).

The low temperature specific heats of two isomorphous Laves compounds, $TiBe_2$ and $ThMg_2$, have been measured. The shape of the transition for the itinerant antiferromagnet $TiBe_2$ is characteristic of magnetic ordering; the entropy of this transition is quite small, approximately 107 mJ/mole-K, a further indication of itinerancy. The γ, proportional to the density of states, is 42 mJ/mole-K^2 for $TiBe_2$, and the Debye temperature, thetasub(D), is 650 K. These numbers are compared to those for the itinerant ferromagnet $ZrZn_2$. The results for $ThMg_2$ are $\gamma = 9.2$ mJ/mole-K^2 and thetasub(D) = 217 K.

10364 μi depolarization in AlGd alloys. Kohn, S.; Brown, J.A.; Heffner, R.H.; Huang, C.Y.; Kitchens, T.A. Jr.; Leon, M.; Olsen, C.E.; Schillaci, M.E. (Los Alamos Scientific Lab., NM (USA)). *Hyperfine Interact.;* **6**: No. 1-4, 283-287(Jan-Feb 1979).

From 1. international topical meeting on muon spin rotation; Rorschach, Switzerland (4 - 7 Sep 1978).

The μ^+ depolarization rate in dilute AlGd alloys containing 50 and 450 atomic ppm Gd was measured in a transverse field of 80 Oe over the temperature range 6-300 K. For both alloys, Λ increased dramatically above 200 K, reaching values of 0.69 and 0.93 μs^{-1}, respectively, near room temperature. The results are interpreted as providing evidence for a thermally-activated trapping mechanism.

10365 Magnetic field on the μ^+ in Ni doped with 0.76 at.% Cu or with 0.76 at.% Co from 5 to 330 K. Kossler, W.J. (College of William and Mary, Williamsburg, VA (USA)); Fiory, A.T.; Minnich, R.P. (Bell Labs., Murray Hill, NJ (USA)); Lankford, W.F. (George Mason University, Fairfax, VA (USA)); Lynn, K.G. (Brookhaven National Lab., Upton, NY (USA)); Stronach, C.E. (Virginia State Coll., Petersburg (USA)). *Hyperfine Interact.;* **6**: No. 1-4, 93-97(Jan-Feb 1979).

From 1. international topical meeting on muon spin rotation; Rorschach, Switzerland (4 - 7 Sep 1978).

Measurements of local magnetic fields and depolarization rates were made as a function of temperature in zero external field in samples of Ni alloyed with either 0.76 at.% Cu or 0.76 at.% Co. At temperatures below 50 K the magnetic field on the μ^+ in the Ni-Cu alloy is 1462+-2 G and for the Ni-Co alloy the field is 1524+-7 G.

10366 μi depolarization measurements of Al alloyed with 0.1 at.% Ag, Cu, Mg, Si, and Zn. Kossler, W.J. (College of William and Mary, Williamsburg, VA (USA)); Fiory, A.T.; Minnich, R.P. (Bell Labs., Murray Hill, NJ (USA)); Lankford, W.F. (George Mason University, Fairfax, VA (USA)); Lynn, K.G. (Brookhaven National Lab., Upton, NY (USA)); Stronach, C.E. (Virginia State Coll., Petersburg (USA)). *Hyperfine Interact.;* **6**: No. 1-4, 295-299(Jan-Feb 1979).

From 1. international topical meeting on muon spin rotation; Rorschach, Switzerland (4 - 7 Sep 1978).

To try to understand the nature of μ^+ trapping by impurities in Al, as has recently been observed for copper impurities, Al alloyed with 0.1 at.% Ag, Cu, Mg, Si and Zn has been studied as a function of temperature and heat treatment.

10367 Magnetization study of UFe_2. Aldred, A.T. (Argonne National Lab., IL (USA)). *J. Magn. Magn. Mater.;* **10**: No. 1, 42-52(Jan 1979).

Bulk magnetization measurements have been performed between 4 and 400 K on oriented samples cut from a single crystal of UFe_2 (cubic C15-type Laves phase) used in an earlier neutron-diffraction study. The easy axis of magnetization was determined to be <111> in all cases, but the samples differed from each other in bulk magnetic properties (particularly Curie temperatures, which varied from 147 to 162 K). These variations apparently reflect small differences in stoichiometry. The upper temperature limit of the measurements was determined by the increasing presence of an 'impurity' magnetization presumably arising from the precipitation of small amounts (approximately 0.01%) of free iron. This result implies that samples of UFe_2 quenched from elevated temperatures are not stable, under equilibrium conditions, near room temperature. Subsequent measurements on polycrystalline samples deliberately prepared with excess uranium (UFesub(2-x)) showed that the C15-type structure persists to at least UFesub(1.7) and that the magnetic properties vary regularly with changes in stoichiometry. The bulk magnetic moment (1.09 μsub(B)/mol) determined from a <111> oriented single crystal is significantly larger than the total moment obtained in the neutron-diffraction study on the same sample.

10368 High-temperature magnetic properties of $AnFe_2$ (An = Np, Pu, Am) Laves phases. Aldred, A.T. (Argonne National Lab., IL (USA)). *J. Magn. Magn. Mater.;* **10**: No. 1, 53-58(Jan 1979).

Magnetization measurements have been performed on $NpFe_2$, $PuFe_2$, and $AmFe_2$ (cubic C15-type Laves phase) between 300 and 1100 K. The Curie temperatures were found to be 492+-2, 564+-2 and 613+-3 K, respectively. A correlation was found between the Curie temperature and magnetic moment per iron atom determined in previous neutron-diffraction experiments. Critical exponents determined for $NpFe_2$ and $PuFe_2$ were found to be close to previously reported values for the chemically ordered metallic system Pd_2Fe. The overall magnetic behavior of the compounds studied implues the presence of local magnetic moments.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 9569, 9713, 9746, 10484

10369 (COO—1198-1292) Effects of surface oxidation on vacancy defects in beta nickel-aluminum alloys. Parthasarathi, A. (Illinois Univ., Urbana (USA). Dept. of Metallurgy and Mining Engineering). 1980. Contract AC02-76ER01198. 147p. Dep. NTIS, PCA 02/MF A01.

Transmission Electron Microscopy and Auger Electron Spectroscopy have been used to make observations of the oxidation process in β-NiAl alloys annealed under controlled conditions of temperature and oxygen partial pressure. Binary Ni-Al alloys, with nominally 47.5, 50.4 and 52.5 at. % Al, were examined. The Auger spectroscopy analysis showed that the predominant oxide formed on these alloys is Al_2O_3, with a possible thin intermediate layer of spinel. Bulk oxidation experiments indicate that the oxide grows by outward diffusion of cations to the oxide/gas interface.

10370 (COO—4014-T1) Fabrication and loading of long-term stress corrosion cracking surveillance specimens for the Dresden 1 decontamination program. Walker, W.L. (General Electric Co., San Jose, CA (USA). Nuclear Energy Engineering Div.). Oct 1979. Contract EY-76-C-02-4014. 66p. Dep. NTIS, PC A04/MF A01.

Stress-corrosion cracking test specimens were prepared for Dow Nuclear Services for insertion in the Dresden 1 reactor during the chemical decontamination of the primary system, and for subsequent exposure under operating conditions when the station returns to service. The specimens consist of pressurized tubes fabricated from Type-304 and -304L stainless steel, Inconel 600, Incoloy 800, and Zircaloy 2. In addition, constant radius bent-beam specimens of 3/4 hard Type-410 stainless steel were also included. All specimens were stressed to, or slightly above, their respective 0.2% offset yield strengths at the temperatures of interest.

10371 (STU—75-3741, pp 25) **Stress corrosion cracking in austenitic materials for nuclear reactors.** Rosborg, B. Nov 1978.

In Testing in a 100 ppm c1 and 0.2 ppm O_2 sodium chloride solution at 320 deb C.

Single U-bends of 18Cr10Ni, 20Cr25Ni, 22Cr34Ni and 17Cr72Ni alloys with different contents of the impurities As, Sb and Bi have been exposed to a 100 ppm Cl^- and 0.2 ppm O_2 sodium shloride solution at 320 deg C in a refreshed autoclave. The 18Cr10Ni U-bends have been exposed for 1000 h and the others for 5000 h. The primary objective of the test was to examine the influence of the impurity additions upon the stress corrosion cracking resistance. Transgranular or mixed inter- and transgranular stress corrosion cracking has been found in 13 out of 35 U-bends of the 18Cr10Ni alloy, 4 out of 35 U-bends of the 20Cr25Ni alloy and 3 out of 30 U-bends of the 22Cr34Ni alloy. Of the impurities As was found to have a deleterious influence on the stress corrosion cracking resistance, but no obvious influence was found for Sb and Bi. While no transgranular cracking was found in the U-bends of the 17Cr72Ni alloy, this nickel-base alloy showed poor pitting resistance and extensive intergranular attack in crevice regions.

10372 **Corrosion of copper-nickel alloys in sea water polluted wth sulfide and sulfide oxidation products.** Syrett, B.C. (Electric Power Research Inst., Palo Alto, CA); Macdonald, D.D.; Wing, S.S. *Corrosion;* **35**: No. 9, 409-422(Sep 1979).

The corrosion rates of copper alloys 706 (90:10 Cu:Ni) and 715 (70:30 Cu:Ni) were measured, using rotating cylinder specimens in sea water that contained oxygen, sulfide, sulfur, and polysulfide, either singly or in combination. In addition a control test was performed using unpolluted deaerated sea water. Corrosion rates were monitored for over 24 hours, using linear polarization and potential step techniques. The work has shown that copper-nickel alloys can corrode quite rapidly in deaerated sea water if these normally passive alloys are made active by the presence of sulfide, or if sulfur is available as an oxidant.

10373 **Mitigation of inside surface residual stress of type 304 stainless steel pipe welds by running water cooling method.** Imai, K.; Itow, H.; Kirihara, S.; Koyama, T.; Maruyama, T.; Masaoka, I.; Miki, M.; Sasaki, R. (Hitachi Ltd. (Japan)). pp 151-158 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978).

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Investigations on the reduction of intergranular stress corrosion (IGSCC) by cooling in air, using running and sprayed water. Accounting for weldings on pipe bends and straight pipes, corrosion test. Excellent IGSCC resistivity of welded pipes by running water cooling.

10374 **New hardsurfacing alloys for wear- and corrosion resistant deposits.** Kruske, G. (Lurgi Chemie und Huettentechnik G.m.b.H., Frankfurt am Main (Germany, F.R.)); Lugscheider, E. (Technische Hochschule Aachen (Germany, F.R.)). pp 97-104 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

Structural condition, chemical and physical properties in comparison with Stellite and selffluxing nickel base alloys. Experiences in practical operations.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 10447, 10488

10375 **Observation of channeling radiation from relativistic electrons.** Swent, R.L.; Pantell, R.H.; Alguard, M.J.; Berman, B.L.; Bloom, S.D.; Datz, S. (Department of Electrical Engineering, Stanford University, Stanford, California 94305). EY-76-S-0326;W-7405-ENG-48;W-7405-ENG-26. *Phys. Rev. Lett.;* **43**: No. 23, 1723-1726(3 Dec 1979).

Radiation from 56-MeV and 28-MeV electrons channeled along major planes or along a major axis of an 18-μm thick silicon crystal has been observed. Unpredicted spectral peaks in the range from 10 to 130 keV were observed and resolved for planar-channeling electrons, whereas only a large low-energy enhancement was seen for axial-channeling electrons.

10376 **Transmission electron microscopy of radiation damage in Nb_3Sn.** Pande, C.S. (Brookhaven National Lab., Upton, NY (USA)). *Phys. Status Solidi (a);* **52**: No. 2, 687-696(16 Apr 1979).

The nature of the defect or defect complexes produced in superconducting compound Nb_3Sn by high energy (E >= 1 MeV) neutron irradiation is studied by transmission electron microscopy. The damage appears to be primarily in the form of highly disordered regions of size 2 to 6 nm in a much less disordered matrix. Both the ordered matrix and the disordered regions essentially retain A15 structure. Using superlattice and fundamental reflections it is shown that the disordered regions contain a high density of antisite defects as well as associated strain fields.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 9564

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 10225

10377 (UCRL—15124) **Feasibility study for ductile machining of glass. Final report January 1, 1979-September 30, 1979.** Finnie, I.; Giovanola, J.; Misra, A.; Glardon, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1979. Contract W-7405-ENG-48. 93p. Dep. NTIS, PC A05/MF A01.

Results are presented of a study aimed at determining the feasibility of the ductile machining of silicate glasses lead-silicate glass is readily amenable to ductile cutting using heptanol cutting fluid. Fused silica displayed no sign of ductile behavior. (FS)

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 10377

10378 **Transformation-toughening in partially-stabilized zirconia (PSZ).** Porter, D.L. (Case Western Reserve Univ., Cleveland, OH); Evans, A.G.; Heuer, A.H. *Acta Metall.;* **27**: No. 10, 1649-1654(Oct 1979).

The significant fracture toughness of optimally-fabricated partially-stabilized zirconia (PSZ) is due to mechanical energy absorption in the vicinity of the tip of a propagating crack due to stress-induced phase transformations occurring within metastable precipitates. Eshelby's transformed-inclusion analysis has been used to model the transformation toughening: a transformation zone is calculated from an energy balance approach, the size of this zone determining the mechanical energy dissipated during crack propagation. The increase in apparent fracture surface energy predicted by the model is in tolerable agreement with experiment, although the model does not account for multiparticle interactions, interfacial energy changes, and transformation-induced twinning.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 10225

10379 (INKA-Conf—79-003-034) **High-temperature vaporization behavior of oxygen-deficient thoria.** Ackermann, R.J.; Tetenbaum, M. (Argonne National Lab., IL (USA)). (Argonne Cancer Research Hospital, Chicago, IL (USA)). 1979. 5p. (IAEA-SM—236/57; CONF-790111—36). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International symposium on thermodynamics of nuclear materials; Julich, F.R. Germany (29 Jan 1979).

The experimental results of the present study on the vaporization behavior of oxygen-deficient thoria are directed toward a more precise and detailed study of the lower phase boundary (l.p.b.) and congruently vaporizing composition (c.v.c), and intermediate compositions, and the corresponding oxygen potentials and total pressure at temperatures above 2000K. The l.p.b. and c.v.c. values were found to fit an equation of the form $\log x = A + (B/T)$, where x is the stoichiometric defect in ThO_2-x. Oxygen potentials corresponding to the l.p.b. and c.v.c. have been estimated from vapor pressures and thermodynamic data. A very sharp decrease in oxygen potential occurs when thoria isreduced only slightly from the stoichiometric composition. In the temperature range from 2400 to 2655 K, the oxygen partial pressure dependency of x in ThO_2-x was found to be approximately proportional to PO_2-1/4to PO_2-1/. The small extent of reduction over a wide range of oxygen potentials at these temperatures is a clear illustration of the higher stability of the ThO_2-x phase compared with that of UO_2-x. Values of ΔHO_2 and ΔSO_2 have been estimated for selected compositions from the dependence of the measured oxygen potential on temperature. Estimates of the standard free energy of formation of bivariant ThO_2-x compositions have been made. A substantial increase in the total pressure of thorium-bearing species occurs when stoichiometric thoria is reduced toward the lower phase boundary.

10380 (INKA-Conf—79-003-038) **Thermodynamic studies of thorium carbide fuel preparation and fuel-clad compatibility.** Besmann, T.M.; Beahm, E.C. (Oak Ridge National Lab., TN (USA). Chemical Technology Div.). (Oak Ridge National Lab., TN (USA)). 1979. 6p. (IAEA-SM—236/61; CONF-790111—37). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International symposium on thermodynamics of nuclear materials; Julich, F.R. Germany (29 Jan 1979).

The carbothermic reduction of thorium and uranium-thorium dioxide to monocarbide has been assessed. Equilibrium calculations have yielded Th-C-O and U-Th-C-O phase equilibria and (CO) pressures generated during reduction. The (CO) pressures were found to be at least five orders of magnitude greater than any of the other 15 gaseous species considered. This confirms that the monocarbide can successfully be prepared by carbothermic reduction. The chemical compatibility of thorium carbides with the Cr-Fe-Ni content of clad alloys has been thermodynamically avaluated. Solid solutions of <$ThNi_5$> and <$ThFe_5$> and of <Cr_7C_3> and <Fe_7C_3> were the principal reaction products. The Cr-Fe-Ni content of 316 stainless steel showed much less reaction product than that for any of the other six alloys considered.

10381 (INKA-Conf—79-003-041) **Photoelectron spectroscopy of 4f, 5f, and 2p orbital electrons and the thermochemistry of uranium oxides.** Murch, G.E.; Thorn, R.J. (Argonne National Lab., IL (USA). Chemistry Div.). (Argonne National Lab., Evanston, IL (USA)). 1979. 4p. (IAEA-SM—236/68; CONF-790111—38). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International symposium on thermodynamics of nuclear materials; Julich, F.R. Germany (29 Jan 1979).

The basic reaction describing the partial pressure of oxygen in equilibrium with UO_2+x is resolved into a set of elementary reactions for which the energies can be obtained through 5f- an 2p-orbital electron energies measured with X-ray photoelectron spectroscopy. It is shown that the energies of the valence orbitals are a direct measure of the oxygen potential and that the orbital binding energies adjusted for the coulombic self potential are linearly related to the ionicity derived from the optical dispersion theory of Phillips and van Vechten. Measurements of the O^{2-} ($1s^2$---) orbital energies in alkaline earth and UO_2 and ThO_2 indicates an ionicity of 0.93 for the two actinide dioxides. From measurements of the intensities of the photoelectron emitted from the 5f orbital in uranium metal, uranium dioxide and uranium tetrafluoride it is shown that the densities of electrons in the 5f orbitals are the same in U,UO_2 and UF_4.

10382 **Quasimolecular Jahn-Teller resonance states in the bcc metallic hydrides of vanadium, niobium, and tantalum.** Abell, G.C. (Monsanto Research Corporation, Mound Facility, Miamisburg, Ohio). DE-AC04-76-DP00053. *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 4773-4788(15 Dec 1979).

The unusual properties of the group Vb bcc hydrides are shown to derive from a particular d-band quasimolecular resonance state localized near interstitial hydrogen. This state is schematically shown to be grounded in fundamentals. The point of departure is an Anderson-Newns approach to the problem of a single hydrogen atom in a transition metal, with the metal states in a mixed nearly-free-electron-tight-binding representation. Orthogonalization of pseudo-plane-wave states to the hydrogen 1s "core" state leads to a Hamiltonian with site-diagonal disorder (Anderson Hamiltonian) for the d band. This gives the possibility of induced, localized d states. Assuming that localized electron states derived from the d band exist and are confined to the shell of metal atoms nearest the impurity, symmetrized linear combinations of atomic orbitals (-molecular orbitals) (LCAO-MO) are constructed for impurity polyhedra in the group Vb metals. A particularly simple <111> distortion proves to be key for understanding previously unexplained properties in the Vb metal-hydrogen systems, viz. cubic lattice distortion, hydrogen diffusion, and excess partial entropy.

10383 **Anomalous conduction-electron polarization in superconducting YRh_4B_4.** Tse, P.K.; Aldred, A.T.; Fradin, F.Y. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **43**: No. 24, 1825-1828(10 Dec 1979).

NMR and magnetization measurements in Y/sub 1-x/Er/sub x/Rh_4B_4 indicate a strong conduction-electron—local-moment interaction with only a weak depression of the superconducting transition temperature T/sub c/. The appearance of large hyperfine interactions below T/sub c/ indicates that a grossly uncompensated conduction electron spin state exists in the superconducting phase of YRh_4B_4. The results are discussed in terms of both itinerant antiferromagnetism and non—s-wave Cooper pairing.

10384 **Comment on "compressibility collapse" transition in ReO_3.** Schirber, J.E.; Azevedo, L.J.; Narath, A. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Phys. Rev., B: Condens. Matter;* **20**: No. 11, 4746-4747(1 Dec 1979).

First- and second-order quadrupolar effects on the Re NMR in ReO_3 have been used to show that the "compressibility collapse" transition results in a high-pressure phase of symmetry lower than cubic and to map out the phase boundary from 1 to 300 K.

10385 **Investigation of the mechanism for Schottky barrier formation by group III metals on GaAs(110).** Skeath, P.; Lindau, I.; Chye, P.W.; Su, C.Y.; Spicer, W.E. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305). *J. Vac. Sci. Technol.;* **16**: No. 5, 1143-1148(Sep 1979).

New evidence for a defect mechanism which is responsible for pinning states within the band gap on the (110) surfaces of the III—V compounds is presented. Investigations of column III metals on both n- and p-type GaAs revealed a systematic difference in surface Fermi energy stabilization in the gap with p-type samples pinning 0.25 eV below n-type samples. Several current models and theories of Schottky barriers are discussed in terms of both the results given in this paper and previously reported data.

10386 **Oxidation of ordered and disordered GaAs(110).** Chye, P.W.; Su, C.Y.; Lindau, I.; Skeath, P.; Spicer, W.E. (Stanford Electronics Laboratories and Stanford Synchrotron Radiation Laboratory, Stanford University, Stanford, California 94305). *J. Vac. Sci. Technol.;* **16**: No. 5, 1191-1194(Sep 1979).

The adsorption of nonexcited molecular oxygen on ordered and disordered(110) surfaces of GaAs was studied using photoemission techniques. On the ordered surface, only one chemically shifted level was observed for the As3d core level up to 10^{13} exposure. The Ga3d core level exhibits an asymmetrical broadening towards higher binding energy for the same exposure, indicating the presence of a shifted component. The percentages of shifted Ga and shifted As appear to be about equal. However, when a sputtered (disordered) surface was exposed to oxygen, there was preferential adsorption on the Ga. Implications of these data are discussed.

10387 **Measurements of interface recombination velocity by capacitance/collection efficiency variation in Cu_2S/CdS heterojunctions.** Convers Wyeth, N.; Rothwarf, A. (Institute of Energy Conversion, University of Delaware, Newark, Delaware 19711). *J. Vac. Sci. Technol.;* **16**: No. 5, 1402-1405(Sep 1979).

The interface recombination velocity S/sub I/ in the Cu_2S/CdS heterojunction has been measured by a new technique using junction capacitance and collection efficiency. The method capitalizes on changes in the junction field strength due to the photocharging of traps in the depletion region, as measured by junction capacitance. The variation in junction collection efficiency is related to the field strength changes to obtain S/sub I/ values of order $\sim 3 \times 10^5$ cm/s. These compare well with estimates from other experiments and simple theoretical predictions. This measurement technique could be applied to other systems, so long as photosensitive trapping states exist that alter the depletion layer width upon external illumination.

COMPOSITE MATERIALS

10388 (NTIS/PS—79/0476) **Boron reinforced composites. Volume 2. 1976-April 1979 (a bibliograpy with abstracts). Report for 1976-April 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). May 1979. 244p. NTIS PC N01/MF N01.

The bibliography cites Federally-funded research on boron fibers and boron compounds used as reinforcing material in composites. Included are studies on fabrication, testing, uses, and structural and mechanical properties. (This updated bibliography contains 236 abstracts, 39 of which are new entries to the previous edition.)

MECHANICAL PROPERTIES

10389 **Model of cyclic inelastic flexural behaviour of reinforced concrete members.** Popov, E.P.; Bertero, V.V. (California Univ., Berkeley (USA)); Ma, S.M. (Bechtel Power Corp., San Francisco, CA (USA)). pp K3/14 1-12 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

Reinforced concrete (RC) structures are commonly used in nuclear power plants to provide housing, shielding and support of essential equipment. Increased concern about the safety of such plants in the event of a strong motion earthquake has directed greater attention to studying the hysteretic behaviour of these structures under cyclic loading. This paper presents a practical mathematical model for predicting the hysteretic behaviour of critical regions (plastic hinges) in RC flexural members designed by using current seismic code provisions (UBC or ACI).

POLYMERS AND PLASTICS

PHYSICAL PROPERTIES

10390 **Stability of high-temperature polymers.** Arnold, C. Jr. (Sandia Labs., Albuquerque, NM). *J. Polym. Sci., Part D;* **14**: 265-378(1979).

Thermal stability of aromatic-heterocyclic organic polymers is surveyed. Highest stabilities were observed with step ladder (SL) and ladder (L) type polymers. Aliphatics were the most stable. Crosslinking generally results in enhanced stability. The stability of polymers containing fused rings appears to decrease as the number of fused chain segments increases. The effect of pendant groups depends on the nature of the group as well as the polymer to which it is bonded. (FS)

DEGRADATION AND EROSION

REFER ALSO TO CITATION(S) 10428

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 9792, 9793, 9794, 9795, 9796, 9797, 9798, 9800, 9802, 9808, 9814, 9815, 9822, 9823, 9828, 9830

10391 (UCID—18491) **Hard surface photomasks with micron and submicron linewidths.** Ciarlo, D.R.; Herrmann, W.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Dec 1979. Contract W-7405-ENG-48. 18p. Dep. NTIS, PC A02/MF A01.

The procedure used to fabricate photomasks for a Gallium Arsenide test chip with edge dimensions of 2.54 by 2.54 mm (100 by 100 mils) containing linewidths as small as 0.8 microns (31.5 μ in.) using equipment belonging to the Technical Photography Group, Rm. 1258, Bldg. 121 is described. Gallium Arsenide Metal Schottky Field Effect Transistors (GaAs MESFET's) require photomasks with micron and submicron linewidths. In addition, the research and development status of this particular project makes it necessary to try out several design iterations in order to accumulate experimental data and verify theories. Each new design iteration requires a new set of photomasks. Commercial mask vendors are reluctant to work on linewidths below two microns at this time, although they will do so at a premium price ($4 K per set). Even if a commercial vendor agrees to make photomasks with one micron lines, the long delivery times encountered (several months) can seriously hurt the momentum of R and D projects.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 10729

10392 Nature of catalytic impurities in synthetic diamonds. An identification using extended x-ray absorption fine structure. Wong, J.; Lytle, F.W. (General Electric Corporate Research and Development, Schenectady, New York 12301). *J. Appl. Phys.;* **51**: No. 1, 280-282(Jan 1980).

Identification using the extended x-ray absorption fine structure technique shows that nickel impurities found in synthetic diamonds exist as fcc Ni and contain an estimated amount of 2.7 +- 1.3 at.% carbon in solution.

10393 X-ray study of intercalate order-disorder transition in $C_{24}K$. Zabel, H.; Moss, S.C.; Caswell, N.; Solin, S.A. (Department of Physics, University of Houston, Houston, Texas 77004). EY-76-S-05-511. *Phys. Rev. Lett.;* **43**: No. 27, 2022-2025(31 Dec 1979).

Below T/sub c/=122.9 °K, $C_{24}K$ shows a transition from the intralayer disordered state to an ordered state. For T>T/sub c/, present diffuse scattering data from the potassium intercalate in graphite indicate a two-dimensional (2-D) character of the short-range order. As this 2-D scattering increases with decreasing temperature, hk0 superlattice reflections appear at T/sub c/ which have a true 3-D character that results from essentially simultaneous intralayer and interlayer ordering. This long-range order vanishes as vertical-bar T-T/sub c/ vertical-bar /sup β/ with β=0.180 +- 0.01.

10394 Electronic structure of metal hydrides. III. Photoelectron spectroscopy studies of ScH_2, YH_2, and LuH_2. Weaver, J.H.; Peterson, D.T.; Benbow, R.L. (Synchrotron Radiation Center, University of Wisconsin-Madison, Stoughton, Wisconsin 53589). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 5301-5312(15 Dec 1979).

Photoelectron spectroscopy with synchrotron radiation has been used to examine the electronic energy bands of ScH/sub 1.85/, YH/sub 1.73/, and LuH/sub 1.77/ for 15 < or = hν < or = 100 eV. The hν-dependent features in the bonding band are discussed in terms of initial-state densities of state and variations in the partial photoionization cross sections. The photoelectron spectroscopy results are combined with those of our earlier optical studies and are used to assess quantitatively the validity of the one-electron band model for d-band metal dihydrides. Good overall agreement is found when compared to the results of recent calculations, notably those of Peterman et al., based on the model proposed by Switendick. Band-structure effects are discussed in detail. Emission from the shallow 3p, 4p, and 5p core levels are revealed through high-photon-energy spectra. Additional features arising from plasmon losses and Auger emission are shown to be important. For LuH_2, the 4f photoionization cross section is determined, and the probability of bulk-plasmon excitations is shown normalized to the 4f cross section.

10395 Atomic structure of clean and arsenic-covered GaAs(110) surfaces. Mrstik, B.J.; Tong, S.Y.; Van Hove, M.A. (Naval Research Laboratory, Washington, D. C. 20375). *J. Vac. Sci. Technol.;* **16**: No. 5, 1258-1261(Sep 1979).

During the past few years there have been several LEED studies to determine the atomic structure of the clean GaAs(110) surface. The LEED data have been analyzed by comparison to both kinematical and dynamical theories, and several different structures have been reported. These structures have ranged from a surface which is unreconstructed to a surface which has the As atoms tilted outward with a tilt angle of 34.8°. We have recently compared our data to results of dynamical calculations and have determined that the best structure has the As atoms rotated outward with a tilt angle of 27°, a Ga to second layer spacing of 1.452 A, and back bonds which are slightly contracted. Differences between this structure and previously reported structures are discussed. We also present preliminary results of our LEED studies on the bonding of an As monolayer to the GaAs(110) surface. We find that the As atoms remove the reconstruction of the clean substrate and adsorb on sites which continue the bulk structure.

PROPERTIES

REFER ALSO TO CITATION(S) 9789, 9791, 10748, 10921, 10938

10396 (GA-A—15573) **Incremental stress-strain law for graphite under multiaxial loadings.** Tzung, F. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract AT03-76ET35300. 33p. Dep. NTIS, PC A03/MF A01.

An incremental stress-strain law for describing the nonlinear, compressible and asymmetric behavior of graphite under tension and compression as well as complex loadings is derived based on a dry friction model in the theory of plasticity. Stress-strain relations are defined by longitudinal-lateral strain measurements for specimens under uniaxial tension-compression. Agreements with experimentally determined curves from biaxial loading experiments are shown. Agreements in finite element computations using the present model with strain measurements for diametral compression and 4-point bend tests of graphite are also obtained.

10397 Characterization of surface oxides by Raman spectroscopy. Farrow, R.L.; Mattern, P.L.; Nagelberg, A.S. (Division of Applied Physics, Sandia Laboratories, Livermore, California 94550). *Appl. Phys. Lett.;* **36**: No. 3, 212-214(1 Feb 1980).

Raman spectroscopy is shown to provide direct information on the composition and structure of surface oxides formed on alloys. Previously, identification of specific compounds present in these oxides only could be inferred from conventional surface analysis methods. In our studies, backscattering spectra were obtained from thick oxide films (greater-than-tilde10 μm) present on high purity and commercial stainless steels after exposure to air and coal gasifier environments at 980 °C. With as-grown oxides, data were obtained from the outer oxide regions. Spectra from inner regions also were measured using grazing-angle sectioning techniques. The presence of impurities and minor alloying constituents in the substrates are shown to have profound effect on results; for example, the addition of a few percent of titanium and manganese resulted in the formation of a duplex scale with a thin, complex, outer layer and a relatively thick α—Cr_2O_3 inner scale.

10398 Piezo- and elasto-optic properties of deuterium oxide under high pressure. Chen, C.C.; Vedam, K. (Materials Research Laboratory and Department of Physics, Penn State University, University Park, Pennsylvania 16802). *J. Chem. Phys.;* **72**: No. 2, 1410-1411(15 Jan 1980).

The variation of the refractive index of D_20 with pressure has been determined using g the high precision optical interferometric method.(AIP)

10399 Precipitation of formaldehyde from solid xenon solutions. Infrared spectra of dissolved and aggregated formaldehyde. Maier, W.B. II; Holland, R.F.; Freund, S.M.; Beattie, W.H. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **72**: No. 1, 264-267(1 Jan 1980).

Optically clear solutions of ≃0.01 mole % formaldehyde in solid xenon have been grown in cells of 1.3 cm thickness. Infrared absorption spectra have been obtained, and near the melting point of xenon the absorption features are fairly similr to those found for formaldehyde dissolved in liquid xenon. As the temperature of the solid solution is lowered,the formaldehyde precipitates from solution and the spectra change considerably. Absorption spectra of aggre-

gated CH_2O and CD_2O have been measured; the mode corresponding to the CO stretch shows considerable structure.

10400 Spin fluctuations in random magnetic-nonmagnetic two-dimensional antiferromagnets. II. Heisenberg percolation. Birgeneau, R.J.; Cowley, R.A.; Shirane, G.; Tarvin, J.A.; Guggenheim, H.J. (Department of Physics and Center for Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., B: Condens. Matter;* **21**: No. 1, 317-332(1 Jan 1980).

In this paper we report an extensive study using neutron scattering techniques of the spin fluctuations in the two-dimensional diluted near-Heisenberg antiferromagnet Rb$_2$Mn/sub c/Mg/sub 1-c/F$_4$. The concentrations studied are c=0.54, c=0.57, and c=0.60; the site-percolation concentration for the nearest-neighbor square lattice is c/sub p/=0.593 so that these experiments span the percolation threshold. The point c=c/sub p/, T=0 represents the percolation multicritical point which terminates the line of second-order transition of the infinite network. We give a detailed description of the theory of the magnetic behavior around the percolation point; as the temperaturelike scaling field we suggest μ (T) =κ_1(T) when κ_1(T) is the inverse correlation length for the associated one-dimensional chain; for the static structure factor we propose the formula S (vertical-barc/sub p/-cvertical-bar,μ,Q) proportional κ/sup eta/ $(\kappa^2+Q^2)^{-1}$,where $\kappa=\kappa$ (vertical-barc/sub p/-cvertical-bar,0)+κ (0,μ); that is, we assume that the geometrical and thermal inverse correlation lengths are simply additive. The c=0.60 sample is found to have a smeared second-order phase transition at about 8 K to a state with two-dimensional long-range order but only weak correlations in the third direction. The spin fluctuations in the precritical region are essentially identical to those in the concentrated systems, thus demonstrating that the phase transition in the c=0.60 infinite network is little affected by the proximity to the percolation threshold.

10401 Electron paramagnetic resonance spectrum of the Γ_8 ground state of Np^{4+} diluted in Cs_2ZrCl_6. Edelstein, N.; Kolbe, W.; Bray, J.E. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., B: Condens. Matter;* **21**: No. 1, 338-342(1 Jan 1980).

The electron-paramagnetic-resonance spectrum of Np^{4+} diluted in $CsZrCl_6$ is analyzed in terms of the theory formulated by Belorizky et al. It is shown that if g/sub J/, the Lande g factor, is allowed to vary freely, a satisfactory fit may be obtained which is consistent with optical and EPR data obtained earlier on other tetrapositive actinide ions in the same host crystal. It is suggested that a better fit between the experimental data and the calculated spectrum may be obtained if the Zeeman mixing between the ground Γ_8 state and the excited Γ_6 state is considered.

10402 Electronic structure of ScH_2. Peterman, D.J.; Harmon, B.N. (Ames Laboratory-USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 5313-5317(15 Dec 1979).

The self-consistent band structure of ScH_2 has been calculated using an improved potential. The results are compared with experiment and with our previous calculation, which used the standard muffin-tin approximation. The new calculation is in much better agreement with thermomodulation and photoemission data and demonstrates the size and character of changes caused by corrections to the standard muffin-tin approximation. Charge-density distributions are also shown which graphically indicate the charge transfer toward the hydrogen position.

10403 Neutron-scattering study of pressure-induced antiferromagnetism in PrSb. McWhan, D.B.; Vettier, C.; Youngblood, R.; Shirane, G. (Bell Laboratories, Murray Hill, New Jersey 07974). *Phys. Rev., B: Condens. Matter;* **20**: No. 11, 4612-4623(1 Dec 1979).

At low temperatures the $4f^2$ configuration of Pr^{3+} in PrSb approaches a singlet-singlet system at the X point as a result of the crystalline electric field and the anisotropy in the exchange. The energy of the longitudinal exciton decreases with applied pressure, and there is a transition at T→0 °K from a Van Vleck paramagnet to an induced-moment antiferromagnet at P/sub c/=3.0 +- 0.2 GPa. The magnetic structure, phase boundary, and magnetic moment have been determined, and they are in qualitative agreement with a molecular-field model for the transition. Near the critical pressure the longitudinal exciton softens with decreasing temperature and then saturates at a finite energy in the vicinity of the ordering temperature. Random phase approximation theories for the dynamics of the singlet-singlet model are not compatible with these results.

10404 New and unified model for Schottky barrier and III—V insulator interface states formation. Spicer, W.E.; Chye, P.W.; Skeath, P.R.; Su, C.Y.; Lindau, I. (Stanford Electronics Laboratories, Stanford University, Stanford, California 94305). *J. Vac. Sci. Technol.;* **16**: No. 5, 1422-1433(Sep 1979).

For n- and p-doped III—V compounds, Fermi-level pinning and accompanying phenomena of the (110) cleavage surface have been studied using photoemission at hν< or ≈300 eV (so that core as well as valence band levels could be studied). Both the clean surfaces and the changes produced, as metals or oxygen are added to those surfaces in submonolayer quantities, have been examined. It is found that, in general, the Fermi level stabilizes after a small fraction of a monolayer of either metal or oxygen atoms have been placed on the surface. Most strikingly, Fermi-level pinning produced on a given semiconductor by metals and oxygen are similar. However, there is a strong difference in these pinning positions depending on the semiconductor: The pinning position is near (1) the conduction band maximum (CBM) for InP, (2) midgap for GaAs, and (3) the valence band maximum (VBM) for GaSb. The similarity in the pinning position on a given semiconductor produced by both metals and oxygen suggests that the states responsible for the pinning resulted from interaction between the adatoms and the semiconductor. Based on the available information on Fermi energy pinning, a model is developed for each semiconductor with two different electronic levels which are produced by removal of anions or cations from their normal positions in the surface region of the semiconductors.

10405 Analysis of error in eigenvalues and eigenvectors determined from EPR data. Fouse, G.W.; Bernhard, W.A. (Univ. of Rochester, NY). *J. Magn. Resonance;* **32**: 191-198(1978).

An approximation method for estimating variance and covariance of EPR-determined eigenvalues and eigenvectors is described with the use of the hyperfine coupling tensor A as an example. The method is tested by comparison with simulation methods. Finally, the error distribution in the eigenvalues and eigenvectors of A are calculated for an example set of EPR single-crystal data. 3 tables.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 10055, 10921

10406 Sputter-induced isotopic fractionation at solid surfaces. Watson, C.C.; Haff, P.K. (A.W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). *J. Appl. Phys.;* **51**: No. 1, 691-699(Jan 1980).

Elemental and isotopic mass fractionation in both binary and multicomponent media are investigated within the framework of the familiar collision-cascade model for sputtering. Some of the most salient features of the phenomenon are explicable on this basis. It is found that the partitioning of beam-deposited energy among the various target components can account for differentiations in the secondary recoil fluxes only on the order of one part per thousand, indicating the importance of the surface potentials when large enrichment effects occur. A mechanism governing the translation of internal recoil fluxes into external sputtered fluxes is proposed in order to account for isotopic fractionation, for which the surface binding effects are assumed to be negligible. The predicted initial fractionations are δ/sub f/(^{40}Ca : ^{44}Ca) =33 parts per thousand in the calcium-containing mineral plagioclase and δ/sub f/(^{40}Ca : ^{44}Ca) =24 parts per thousand in CaF_2, in reasonable agreement with recent data on isotopic fractionation.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 10527

10407 Complexes of technetium with pyrophosphate, etidronate, and medronate. Russell, C.D.; Cash, A.G. (Veterans Administration Medical Center, Birmingham, AL). *J. Nucl. Med.;* **20**: No. 6, 532-537(Jun 1979).

The reduction of [^{99}Tc]pertechnetate was studied as a function of pH in complexing media of pyrophosphate, methylene diphosphonate (MDP), and ethane-1, hydroxy-1, and 1-diphosphonate (HEDP). Test (sampled d-c) and normal-pulse polarography were used to study the reduction of pertechnetate, and normal-pulse polarography (sweeping in the anodic direction) to study the reoxidation of the products. Below pH 6 TcO_4^- was reduced to Tc(III), which could be reoxidized to Tc(IV). Above pH 10, TcO_4^- was reduced in two steps to Tc(V) and Tc(IV), each of which could be reoxidized to TcO_4^-. Between pH 6 and 10 the results differed according to the ligand present. In pyrophosphate and MDP, TcO_4^- was reduced in two steps to Tc(IV) and Tc(III); Tc(III) could be reoxidized in two steps to Tc(IV) and TcO_4^-. In HEDP, on the other hand, TcO_4^- was reduced in two steps to Tc(V) and Tc(III), and could be reoxidized to Tc(IV) and TcO_4^-. Additional waves were observed; they apparently led to unstable products.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 10413, 10414, 10415, 10416, 10524

CHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 9650, 10529, 10532

10408 (BM-RI—8391) **Determination of hydrogen sulfide content in natural gas, evaluation of containers for preparation of calibration standards, and sample collection procedure.** Rhodes, H.L. (Bureau of Mines, Amarillo, TX (USA)). 1979. 15p. Bureau of Mines, Pittsburgh, PA.

The Bureau of Mines has developed a method for determining the H_2S content in natural gas samples. A gas chromatograph with a flame photometric detector was used to analyze samples with H_2S concentrations ranging from 5000 ppM to a minimum detectable limit of 0.01 ppM. A mass spectrometer was used to analyze samples containing H_2S in amounts greater than 5000 ppM. Methods are presented for preparing containers for H_2S samples and for preparing standards using partial pressure and weighed standard methods. Sample collection techniques are discussed, as are analytical results which illustrate the loss of H_2S while in the sample container and provide a basis for evaluating containers used for sampling and standard preparation.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 9737

10409 (K/TL—865) **Radioanalysis of technetium-99 at the Oak Ridge Gaseous Diffusion Plant.** Rucker, T.L.; Mullins, W.T. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 13 Sep 1979. Contract W-7405-ENG-26. 15p. (CONF-791049—24). Dep. NTIS, PC A02/MF A01.

From 23. conference on analytical chemistry in energy technology; Gatlinburg, TN, USA (9 Oct 1979).

Technetium-99 is determined in various media by measuring its beta activity using liquid scintillation spectrometry. The use of liquid scintillation spectrometry reduces the time and simplifies preparation of the samples for counting. Some types of samples are analyzed by direct counting procedures which involve no chemical separation. For samples which require a separation of the technetium from uranium and its daughters, a simple hydroxide precipitation removes the interfering elements. This separation technique is faster and more reliable than previously used solvent extraction methods and provides adequate specificity for use at the Oak Ridge Gaseous Diffusion Plant.

10410 (PNL-SA—6601) **Rapid nondestructive plutonium isotopic analysis.** Fager, J.E.; Brauer, F.P. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 7p. (CONF-780522—11). Dep. NTIS, PC A02/MF A01.

From ANS topical meeting; Williamsburg, VA, USA (15 May 1978).

Methods for plutonium isotopic measurements have been evaluated for nuclear safeguards inventory verification. A mobile, real-time, nondestructive assay, gamma-ray spectrometric measurement system has been assembled, moved and operated at several nuclear storage facilities to perform rapid, real-time plutonium isotopic measurements on Pu metal, Pu nitrate and Pu oxide.

10411 (RHO-SA—122) **Continuous-flow apparatus for determination of ^{90}Sr in mixtures of fission products.** Jewett, J.R. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Jul 1979. Contract EY-77-C-06-1030. 19p. (CONF-7909110—1). Dep. NTIS, PC A02/MF A01.

From Federation of Analytical Chemistry and Spectroscopy Societies conference; Philadelphia, PA, USA (17 Sep 1979).

Strontium-90 is determined at Rockwell Hanford Operations in nuclear waste processing plant solutions, and liquid and gaseous effluents. The ^{90}Sr is separated from these samples by liquid/liquid extraction, evaporated to dryness on a stainless steel counting dish, then determined by gross beta counting with a gas proportional counter. This solvent extraction method is based on the selective extraction of various radionuclides by TBP and TTA in 4-methyl-2-pentanone. 15 figures.

10412 (UCID—18508) **Measurement of sulfur content of fluids by x-ray fluorescence.** Ryon, R.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1979. Contract W-7405-ENG-48. 7p. Dep. NTIS, PC A03/MF A01.

A nondestructive method is described for the quantitative measurement of sulfur in oils and water. The method is rapid, sensitive, and accurate. A wavelength dispersive x-ray spectrometer is used. Excitation is produced by a rhodium target, grounded cathode, 0.005-in. Be end window x-ray tube. When a 35-mm-diam specimen cell is used, 1% sulfur in oil yields 19,000 c/s. The detection limit for sulfur in oil is estimated to be less than 5 ppM.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 9718, 10424, 10524, 10532

10413 (IS—4713) **Multilaboratory analytical quality control for the hydrogeochemical and stream sediment reconnaissance.** D'Silva, A.P.; Floyd, M.A.; Haas, W.J. Jr. (Ames Lab., IA (USA)). Sep 1979. Contract W-7405-ENG-82. 44p. Dep. NTIS, PC A03/MF A01.

For the month of August 1979, Ames Laboratory received the following results from the Oak Ridge Gaseous Diffusion Plant: Water A5-0.98 ppBU (4 F); Water B5-9.00 ppb U (4 F); Sediment R3-5 ppm U (17 F, 15 DNC); and Sediment S1-10 ppm U(7 F, 11 DNC). Fluorometric analyses are indicated by F and delayed neutron counting analyses are indicated by DNC.

10414 (IS—4716) **Multilaboratory analytical quality control for the hydrogeochemical and stream sediment reconnaissance. Quality control report, September 1979.** D'Silva, A.P.; Floyd, M.A.; Haas, W.J. Jr. (Ames Lab., IA (USA)). Oct 1979. Contract W-7405-ENG-82. 30p. Dep. NTIS, PC A03/MF A01.

For the month of September 1979, Ames Laboratory received the following number of results: from Los Alamos Scientific Laboratory, Water A5-0.98 ppb U (4 F) and Water B5-9.00 ppb U (4 F), and from the Oak Ridge Gaseous Diffusion Plant, Sediment R3-5 ppm U (11 F, 7 DNC) and Sediment S3-10 ppm U (7 F, 5 DNC). F indicates fluorometric analyses and DNC indicates delayed neutron counting.

10415 (IS—4719) **Multilaboratory analytical quality control for the hydrogeochemical and stream sediment reconnaissance. Quality control report, October 1979.** D'Silva, A.P.; Floyd, M.A.; Haas, W.J. Jr. (Ames Lab., IA (USA)). Dec 1979. Contract W-7405-ENG-82. 43p. Dep. NTIS, PC A03/MF A01.

Ames Laboratory received the following results for the month of October 1979: from Los Alamos Scientific Laboratory, Water A5-0.98 ppb U (4 F), Water B5-9.00 ppb U (4 F); and from the Oak Ridge Gaseous Diffusion Plant, Water A5-0.98 ppb U (3 F), Water B5-9.00 ppb U (1 F), Sediment Q1-0.5 ppm U 7 F), Sediment R3-5 ppm U (14 F, 11 DNC), and Sediment S3-10 ppm U (11 F, 5 DNC). Fluorometric analyses are indicated by F and delayed neutron counting analyses are indicated by DNC.

10416 (IS—4724) **Multilaboratory analytical quality control for the hydrogeochemical and stream sediment reconnaissance. Quality control report, November 1979.** D'Silva, A.P.; Floyd, M.A.; Haas, W.J. Jr. (Ames Lab., IA (USA)). Jan 1980. Contract W-7405-ENG-82. 36p. Dep. NTIS, PC A03/MF A01.

For the month of November 1979, the following number of results were received: from Los Alamos Scientific Laboratory, Water A6-0.95 ppb U (6 F), Water B6-9.85 ppb U (7 F); from Oak Ridge Gaseous Diffusion Plant, Water A 6-0.95 ppb U (7 F), Water B6-9.85 ppb U (1 F), Sediment Q1 (8 F), Sediment R3 (7 F), Sediment S3 (6 F); and from Savannah River Laboratory, Sediment R1 (22 DNC), Sediment S1 (17 DNC), Sediment T1 (20 DNC). Fluorometric analyses are indicated by F and delayed neutron counting analyses by DNC.

10417 (LA—7824) **Spectrochemical determination of beryllium and lithium in stream sediments.** Gallimore, D.L.; Hues, A.D.; Palmer, B.A.; Cox, L.E.; Simi, O.R.; Bieniewski, T.M.; Steinhaus, D.W. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 22p. Dep. NTIS, PC A02/MF A01.

A spectrochemical method was developed to analyze 200 or more samples of stream sediments per day for beryllium and lithium. One part of ground stream sediment is mixed with two parts graphite-SiO_2 buffer, packed into a graphite electrode, and excited in a direct-current arc. The resulting emission goes to a 3.4-m, direct-reading, Ebert spectrograph. A desk-top computer system is used to record and process the signals, and to report the beryllium and lithium concentrations. The limits of detection are 0.2 $\mu g/g$ for beryllium and 0.5 $\mu g/g$ for lithium. For analyses of prepared reference materials, the relative standard deviations were 16% for determining 0.2 to 100 $\mu g/g$ of beryllium and 15% for determining 0.5 to 500 $\mu g/g$ of lithium. A correction is made for vanadium interference.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 10524

10418 (COO—4073-3) **Chelating extractants of improved selectivity. Progress report, August 1, 1978-July 31, 1979.** (Arizona Univ., Tucson (USA)). Aug 1979. Contract EY-76-S-02-4073. 4p. Dep. NTIS, PC A02/MF A01.

During the current contract period, the variation of coordination number of tervalent lanthanides observed earlier with 8-quinolinol extraction systems was exploited in the development of mixed

ligand (so-called synergistic) extraction systems involving 1, 10-phenanthroline (phen) and 8-quinolinol (HOx). Using a mixture of HOx and phen significantly enhanced the difference between adjacent lanthanide ions and facilitated their separation.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

10419 Theoretical study of the potential energy surface for $OH+H_2$. Walch, S.P.; Dunning, T.H. Jr. (Theoretical Chemistry Group, Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *J. Chem. Phys.;* **72**: No. 2, 1303-1311(15 Jan 1980).

Barrier heights and transition state geometries have been calculated for the reaction $OH+H_2 \rightarrow H_2O+H$ using large scale POL-CI wave functions (based on GVB wave functions using basis sets of up to triple zeta valence plus double zeta polarization quality). The saddle point geometry is found to be coplanar and to resemble $OH+H_2$ as expected because of the large exoergicity (~16 kcal/mole) of the reaction. The OH distance of the OH moiety is essentially the same as for the OH molecule, while the HH distance of the H_2 moiety is 0.10 A (~14%) longer than for H_2. The distance from the O to the near hydrogen of the H_2 moiety is 0.35 A (~36%) longer than for the H_2O molecule. The HOH angle is 98° and the H_2 moiety is tilted from collinearity with the O atom by 15° toward the H of the OH moiety. The calculated barrier height using a [4s3p2d/3s2p] basis set is 6.2 kcal/mole. Transition state theory calculations (including a Wigner tunneling correction) using the theoretically computed surface predict rate constants which are in excellent agreement with experiment over the temperature range of 300—2000 °K.

10420 Theoretical study of the potential energy surface for $O(^3P)+H_2$. Walch, S.P.; Dunning, T.H. Jr.; Raffenetti, R.C.; Bobrowicz, F.W. (Theoretical Chemistry Group, Chemistry Division, Argonne National Laboratory, Argonne,Illinois 60439). *J. Chem. Phys.;* **72**: No. 1, 406-415(1 Jan 1980).

Barrier heights and transition state geometries have been calculated for the reaction $O(^3P)+H_2 \rightarrow OH+H$ using large scale POL-CI wave functions (based on GVB wave functions using basis sets of up to triple zeta valence plus double zeta polarization quality). A detailed study was made of the effects on the calculated barrier height and saddle point geometry of (i) basis set, (ii) choice of orbitals, and (iii) choice of reference configurations. Calculations using a [4s3p2d/3s2p] basis lead to a collinear saddle point with r/sub HH/=0.92 A and r/sub OH/=1.23 A with a corresponding barrier height of 12.5 kcal/mole. There are two surfaces which connect the reactants with the products: one of $^3A'$ symmetry and one of $^3A''$ symmetry (these correspond to the two degenerate components of the ^3Pi state in collinear geometries). In the transition state region, the $^3A'$ surface has a steeper bending curve than the $^3A''$ surface leading to significantly different reaction rates on the two surfaces.

10421 Ab initio calculation of the rate constant for the $OH+H_2 \rightarrow H_2O+H$ reaction. Schatz, G.C.; Walch, S.P. (Theoretical Chemistry Group, Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **72**: No. 1, 776-778(1 Jan 1980).

The rate constants for $OH+H_2$ reactions are calculated, using the reagent and saddle point parameters from table I and 6.2 kcal/mole barrier estimate. (AIP)

10422 Thermal oxidation of InP. Wager, J.F.; Wilmsen, C.W. (Colorado State University, Fort Collins, Colorado 80523). *J. Appl. Phys.;* **51**: No. 1, 812-814(Jan 1980).

The growth rate and chemical composition of thermally grown oxides on InP in dry oxygen are presented. The oxide is found to grow very slowly below 340 °C and rapidly above this temperature. All the oxides grown in the temperature range 340—450 °C are composed of approximately 70%—75% In_2O_3 and 25%—30% P_2O_5. There is also some evidence for low concentrations of another bonding state of phosphorous.

10423 Identification by x-ray diffraction of MoS_2 in used Co-Mo-Al_2O_3 desulfurization catalysts. Pollack, S.S.; Makovsky, L.E.; Brown, F.R. (Dept. of Energy, Pittsburgh, PA). *J. Catal.;* **59**: No. 3, 452-459(15 Oct 1979).

The nature of the molybdenum species in supported molybdena hydrodesulfurization (HDS) catalysts is still a matter of controversy. The primary controversy is whether the molybdenum exists as a monolayer across the support surface or in three-dimensional units. This note reports the results of an x-ray diffraction study of a commercial, Harshaw 0402T, Co-Mo-SiO_2-Al_2O_3 catalyst untreated, sulfided, and after use as a hydrodesulfurization catalyst for coal. The patterns for the sulfided show the absence of nordstrandite and $CaMoO_4$, and the presence of eta-alumina and poorly crystalline MoS_2. It is difficult to assess the exact role of the MoS_2 crystalites in regard to the HDS function of the catalyst. It is possible that two- or three-dimensional or amorphous MoS_2 has activity and that the noted deactivation of the catalyst occurred through a mechanism independent of the structure of the active (molybdenum) components. The molybdenum-sulfur species could still be catalytically active for HDS reactions, but are precluded from so functioning because of diffusional limitations resulting from deposited metals or mineral matter from the coal or formed intractable carbinaceous materials (coke). On the other hand, it is possible that change in the MoS_2 crystallites is symptomatic of the actual deactivation mechanism. 1 figure, 2 tables.

10424 Spectroscopic and theoretical studies of metal cluster complexes. 1. The He(I)photoelectron spectrum of Re_3Cl_9. Calculations by the SCC DV Xα method of Re_3Cl_9 and $Re_2Cl_8^{2-}$. Trogler, W.C. (Northwestern Univ., Evanston, IL); Ellis, D.E.; Berkowitz, J. *J. Am. Chem. Soc.;* **101**: No. 20, 5896-5901(26 Sep 1979).

The gas-phase photoelectron spectrum of Re_3Cl_9 has been measured at ca. 800°K. The first vertical ionization potential occurs at 8.85 eV. Results of a discrete variational Hartree-Fock-Slater calculation suggest that this ionization be attributed to a $^2E''$ state. Spin-orbit splitting of the first ionization band also supports this assignment. Charge density contributions to this orbital are distributed over the Re 5d, bridging Cl 3p, and axial Cl 3p orbitals in a 5:2:3 ratio. Remaining features in the photoelectron spectrum and the proposed orbital assignments are as follows: 9.80 eV, $22e''$; 9.90 eV, $18a_2''$, $12a_2'$, $40e'$; 10.47 eV, $21e''$; 10.83 eV, $39e'$, $17a_2''$, $5a_1''$; 11.09 eV, $28a_1'$, $20e''$, $38e'$; 11.83 eV, $16a_2''$, $37e'$; 12.21 eV, $11a_2'$, $36e'$; 13.06 eV, $27a_1'$; 13.39 eV, $15a_2''$, $19e''$, $26a_1'$; 13.86 eV, $35e'$. A unique feature of bonding in this complex is the great stability of $25a_1'$, the cluster σ-bonding orbital. Chemically, this manifests itself in a trans effect at the vertices of the trinuclear cluster framework. To allow a fair comparison between Re_3Cl_9 and the well-studied $Re_2Cl_8^{2-}$ ion, a calculation of the latter complex's electronic structure was also performed. A detailed comparison of the valence orbitals in these two molecules follows. 25 references, 5 figures, 3 tables.

10425 Advances in cleaning metal and glass surfaces to micron-level cleanliness. Stowers, I.F. (Univ. of California, Livermore). Contract W-7405-ENG-48. *J. Vac. Sci. Technol.;* **15**: No. 2, 751-754(Mar 1978).

A high-pressure 6.9-MPa liquid spraying technique has been developed to remove small (> 5μm) contaminant particles from large (100 m^2) surface areas. Chemically polished and etched 304 stainless-steel components are solvent sprayed to achieve cleanliness levels of less than 10 particle/cm_2 > 5μm diameter. The high-pressure and high-liquid-velocity cleaning technique can remove 99.9% of > 5-μm-diam particles in 5 to 10 s compared to only 20 to 60% > 5-μm particles by ultrasonic cleaning in 2 to 10 min. High levels of particulate cleanliness are required for large solid-state laser systems where contaminants may migrate to optical surfaces and cause severe pitting. The pitted glass must be removed and periodically repolished to maintain acceptable beam quality. Special Class 100 clean room procedures and equipment have been developed to determine the degree of cleanliness of laser components and to maintain cleanliness during installation and operation. Development of these cleaning procedures resulted in greatly reduced failure rates for solid-state disk amplifiers. Although developed specifically for cleaning optical components, the basic technique should find wide application in any field requiring particulate-free surfaces. 8 figures, 1 table.

ISOTOPE EFFECTS

10426 Isotope effect in multiphoton ultraviolet photolysis of CO. Bokor, J.; Zavelovich, J.; Rhodes, C.K. (Department of Electrical Engineering, Stanford University, Stanford, California 94305). *J. Chem. Phys.;* **72**: No. 2, 965-971(15 Jan 1980).

Two-photon dissociation of carbon monoxide near 193 nm with a tunable A^1F^* laser to yield excited $C(2\ ^1D)$ atoms is reported. The atoms are detected by subsequent absorption of a third laser photon to $C(3\ ^1P^0)$ followed by emission of 248 nm fluorescence to $C(2\ ^1S)$. The process is found to be isotopically sensitive; the $C(2\ ^1D)$ yield from $^{13}C\ ^{16}O$ and $^{12}C\ ^{18}O$ is a factor of 6 greater than from $^{12}C\ ^{16}O$. The isotope effect is attributable to an enhancement in the two-photon matrix element due to the shift in the near resonant a ^2Pi, v=2 intermediate state. C_2 Swan band emission is also observed, arising from association of the free carbon atoms, and exhibits a corresponding isotope effect. Finally, collisional processes are observed involving excited carbon atoms and electrons, using two-photon ionization of a small quantity of added xenon atoms as a new technique for producing a controlled density of free electrons.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 10433

10427 (N—79-18757) **On the possibility to separate isotopes by means of a rotating plasma: isotope separation with a hollow cathode discharge.** Boeschoten, F.; Komen, R. (Technische Hogeschool Eindhoven (Netherlands)). Mar 1977. 38p. NTIS PC A03/MF A01.

Separation of isotopes by means of a rotating plasma column was investigated. In spite of high rotational velocities, direct separation in the plasma did not seem promising because of the high temperature of the plasma. Therefore, emphasis was placed on the possibility of driving a neutral gas with the plasma in a set up which has some similarities with an ultra centrifuge. It is difficult to evaluate the role of neutral particles in the discharge. Even in relatively small concentrations, neutral particles may be of great importance in a highly ionized plasma. An unforeseen axial temperature gradient in the plasma of the hollow cathode discharge (caused by charge exchange collisions) leads to domination of the axial separative effects over radial effects and to breakdown of the proposed scheme. In pure argon gas static separation factors of maximal 1.3 were found. Even if substantial technical difficulties are left out of consideration it seems that isotope separation by means of a rotating plasma is not of practical interest.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

10428 (UCRL—52849) **Study of the aging processes in polyurethane adhesives using thermal treatment and differential calorimetric, dielectric, and mechanical techniques. I. Identifying the aging processes. II. Quantifying the aging effect.** Althouse, L.P.; Hetherington, N.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Nov 1979. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

It is shown that the thermal aging of polyurethane adhesives involves competitive mechanisms that occur simultaneously as a function of time and temperature. These mechanisms involve chain scission and formation of pseudocrystalline domains. 12 figures, 2 tables.

10429 **Absolute rate parameters for the reaction of $O(^3P)$ with H_2CO over the temperature range 250 to 750 K.** Klemm, R.B.; Skolnik, E.G.; Michael, J.V. (Department of Energy and Environment, Brookhaven National Laboratory, Upton, New York 11973). *J. Chem. Phys.;* **72**: No. 2, 1256-1264(15 Jan 1980).

Absolute rate constants for the reaction of ground state oxygen atoms with formaldehyde were determined over the temperature range 298 to 748 K using the discharge flow-resonance fluorescence technique. The results were combined with rate data from a flash photolysis-resonance fluorescence study (250 to 498 K) of this reaction to obtain an Arrhenius expression that is linear from 250 to 748 K: $k_1(T) = (2.94 +- 0.26) \times 10^{-11} \exp(-3065 +- 67/RT)$ cm^3 $molecule^{-1}$ s^{-1}. This result is compared with those of previous studies and possible kinetic complications are discussed in terms of a detailed mechanism. The significance of an extrapolation of this determination of k_1 to higher and lower temperatures is also discussed.

10430 **Experimental study of resolution of proton chemical shifts in solids: Combined multiple pulse NMR and magic-angle spinning.** Ryan, L.M.; Taylor, R.E.; Paff, A.J.; Gerstein, B.C. (Ames Laboratory, U. S. Department of Energy, and Department of Chemistry, Iowa State University, Ames, Iowa 50011). *J. Chem. Phys.;* **72**: No. 1, 508-515(1 Jan 1980).

High-resolution nuclear magnetic resonance spectra of protons in rigid, randomly oriented solids have been measured using combined homonuclear dipolar decoupling (via multiple pulse techniques) and attenuation of chemical shift anisotropies (via magic-angle sample spinning). Under those conditions, isotropic proton chemical shifts were recorded for a variety of chemical species, with individual linewidths varying from about 55 to 110 Hz (1—2 ppm). Residual line broadening was due predominately to (i) magnetic-field instability and inhomogeneity, (ii) unresolved proton—proton spin couplings, (iii) chemical shift dispersion, (iv) residual dipolar broadening, and (v) lifetime broadening under the multiple pulse sequences used. The magnitudes of those effects and the current limits of resolution for this experiment in our spectrometer have been investigated. The compounds studied included organic solids (4, 4'-dimethylbenzophenone, 2, 6-dimethylbenzoic acid, and aspirin), polymers (polystyrene and polymethylmethacrylate), and the vitrain portion of a bituminous coal.

10431 **Potentiometric study of the reactions of some anions with 1,2,4,6-tetraphenylpyridinium acetate. II. Organic anions.** Selig, W. (Univ. of California, Livermore). Contract W-7405-ENG-48. *Mikrochim. Acta;* 359-371(1978).

From 9. JANNAF propellant characterization subcommittee meeting; Colorado Springs, CO, USA (6 Jun 1978).

This paper is a survey of the types of organic compounds which can be determined potentiometrically with 1,2,4,6-tetraphenylpyridinium acetate (TPPA), it contains details on the precision of the method, the pH ranges in which it is applicable, and the optimum pH. The titrant was approximately 0.05N TPPA in 0.3N aqueous sodium acetate. Titrations were performed at ambient temperature. Emf's were monitored with a perchlorate ion-selective electrode and a double-junction reference electrode. The nitrate and fluoroborate ion-selective electrodes also responded to the various anions. The classes of compounds which can be determined are nitroform and some nitroform-yielding compounds, phenylborates, 2,4,6-trinitro compounds, some dinitrophenols and nitrophenols, some halogenated phenols and others. 2 figures, 6 tables. (DP)

10432 **Vapor-flow calorimetry of benzene.** Todd, S.S.; Hossenlopp, I.A.; Scott, D.W. (Energy Research and Development Administration, Bartlesville, OK). *J. Chem. Thermodyn.;* 641-648(1978).

Vapor-flow calorimetry of benzene was repeated with improved apparatus over larger ranges of pressure and temperature. Experimental values are reported for the enthalpy of vaporization, vapor heat capacity in the real and ideal-gas states, and the second virial coefficient. 2 figures, 3 tables.

ISOTOPE EFFECTS

10433 (COO—3127-31) **Stable isotope studies. Annual progress report, December 1, 1978-November 30, 1979.** Ishida, T. (City Univ. of New York, NY (USA)). 14 Dec 1979. Contract EY-76-S-02-3127. 83p. Dep. NTIS, PC A05/MF A01.

The BBIR-Type precision cryostat was debugged, and interfacing of the cryostat with an LSI-11-based microcomputer was completed. A program for the cryostat control and data acquisition was written. A spiral quartz gauge for the absolute pressure measurements up to 1500 torr has been calibrated against a dead-weight gauge. The vapor pressures of $^{12}CHF_3$, $^{13}CHF_3$, and $^{12}CDF_3$ have been measured in the cryostat at temperatures between -139.85°C and -80.81°C. The carbon isotope effects observed are inverse effect, i.e., $P(^{13}C) > P(^{12}C)$, while the hydrogen isotope effect observed are normal effect, $P(H) > P(D)$. The observed carbon vapor pressure isotope effects point to a second cross-over temperature at 218.66°K, at which $P(^{13}C) = P(^{12}C)$. A plot of $T \ln(P'/P)$ against $1/T$ for the observed D/H vapor pressure isotope effects indicates a positive intercept with the ordinate. These anomalies are explainable on the basis of the blue-shift in the C-H stretching frequency in fluoroform. Besides the isotopic species of fluoroform, methylfluoride was also purified to reduce all chemical impurities to a level below 10 ppM. The construction of nitrogen-15 fractionation system using gaseous nitric oxide under pressure and liquid dinitrogen trioxide, which was started during 1978, was continued. A new scheme for the determination of unit stage separation factor (α) for isotope exchange reactions has been devised,which combines the advantages of the cascade method and the single-stage method. An analytical expression has been developed for the effect of a differential change in a vibrational force constant upon isotopic reduced partition function ratio.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 9693

10434 **High-temperature photochemistry reactor for kinetic studies of isolated elementary gas-phase reactions.** Felder, W.; Fontijn, A.; Volltrauer, H.N.; Voorhees, D.R. (AeroChem Research Laboratories, Inc., P.O. Box 12, Princeton, New Jersey 08540). *Rev. Sci. Instrum.;* **51**: No. 2, 195-200(Feb 1980).

A reactor suitable for kinetic measurements on photolytically initiated elementary free-radical reactions over approximately the 300—1900 K temperature range is described. Performance data are given for the $O + CH_4 \rightarrow OH + CH_3$ reaction.

10435 **Ozone photolysis: A determination of the electronic and vibrational state distributions of primary products.** Sparks, R.K.; Carlson, L.R.; Shobatake, K.; Kowalczyk, M.L.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). W-7405-ENG-48. *J. Chem. Phys.;* **72**: No. 2, 1401-1402(15 Jan 1980).

A high resolution molecular beam measurement of the energy spectra of O_3 photolysis products was performed at 266 nm. (AIP)

10436 **Calculation of fluence-dependent dissociation probabilities in infrared multiple-photon photolysis.** Herman, I.P. (Physics Department, Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *Opt. Lett.;* **4**: No. 12, 403-405(Dec 1979).

Exact analytical expressions are derived for the expected dissociation yield in bulk infrared photolysis experiments; these

results are based on a power-law fluence-dependent model of infrared multiple-photon dissociation as applied to the interaction of a focused, Gaussian-profiled pulsed laser with a medium.

RADIATION CHEMISTRY

10437 ESR—ENDOR studies of x-irradiated glucose-1-phosphate dipotassium salt. Locher, S.E.; Box, H.C. (Biophysics Department, Roswell Park Memorial Institute, Buffalo, New York 14263). *J. Chem. Phys.;* **72**: No. 2, 828-832(15 Jan 1980).

Single crystals of the dipotassium salt of gluocose-1-phosphate were grown out of water or deuterium oxide and x-irradiated at 4.2 °K. The products of irradiation were identified by means of ESR and ENDOR spectroscopy. In crystals grown out of water, three different alkoxy radicals were observed as oxidation products. In partially deuterated crystals only one of the aforementioned alkoxy radicals was produced. A hydroxyalkyl radical, RHCOH was also produced by loss of hydrogen from the C6' position. Electrons trapped at intermolecular sites were identified. The distances between the electron and the protons of the polar hydroxy groups forming the trap were deduced from ENDOR measurements and found to be relatively large, namely 1.732 and 1.738 A.

10438 ESR—ENDOR study of x-irradiated α-methyl-D-glucopyranoside single crystals at 12 K: Influence of hydrogen bonding on primary alcohol group radiation chemistry. Madden, K.P.; Bernhard, W.A. (Department of Radiation Biology and Biophysics, School of Medicine and Dentistry, University of Rochester, Rochester, New York 14642). *J. Chem. Phys.;* **72**: No. 1, 31-33(1 Jan 1980).

Single crystals of α-methyl-D-glucopyranoside x-irradiated at 12 K contain a primary alkoxy radical. In contrast to the previously characterized primary alkoxy radical found at 77 K, the C—O bond does not significantly reorient. This result, as well as deprotonation of an accompanying primary hydroxyalkyl radical, is explained by the presence of three, instead of the usual two, hydrogen bonds about the O_6 atom.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

REFER ALSO TO CITATION(S) 9692

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 9693, 10381, 10425

10439 (LA—8023-PR, pp 135-144) **Organic and biochemical synthesis group (H-11).** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Several ongoing research programs on the synthesis of labelled compounds, the demonstration of applications, analytical organic chemistry, and the development of mouse limb bud system as a screening test for teratogenic chemicals were summarized. The synthesis of Methyl Oleate-1-C13, D-Glucose-6-C13, L-Leucine-3,4-C13, 1-Methylimidazol-$^{15}N_2$ were described. The use of stable isotopes in biosynthesis studies was discussed. Nuclear magnetic resonance studies with ^{13}C-DNA were described. Stable isotopes in electron paramagnetic resonance measurements were described. The mouse limb bud project was discussed. (DC)

10440 (PNL-SA—7187) **Contaminated concrete surface layer removal.** Halter, J.M.; Sullivan, R.G. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Sep 1978. Contract EY-76-C-06-1830. 21p. (CONF-780907—7). Dep. NTIS, PC A02/MF A01.

From 4. conference on contamination; Washington, DC, USA (10 Sep 1978).

Equipment is being developed to economically remove contaminated concrete surfaces in nuclear facilities. To be effective this equipment should minimize personnel radiation exposure, minimize the volume of material removed, and perform the operation quickly with the least amount of energy. Several methods for removing concrete surfaces are evaluated for use in decontaminating such facilities. Two unique methods especially suited for decontamination are described: one, the water cannon, is a device that fires a high-velocity jet of fluid causing spallation of the concrete surface; the other, a concrete spaller, is a tool that exerts radial pressure agains the sides of a pre-dilled shallow cylindrical hole causing spallation to occur. Each method includes a means for containing airborne contamination. Results of tests show that these techniques can rapidly and economically remove surfaces, and leave minimal rubble for controlled disposal.

RADIOISOTOPE PRODUCTION

REFER ALSO TO CITATION(S) 10450

10441 (COO—4318-2) **Preparation of gallium-68 radiopharmaceuticals for positron tomography. Progress report, November 1, 1978-October 31, 1979.** Welch, M.J. (Washington Univ., St. Louis, MO (USA). Edward Mallinckrodt Inst. of Radiology). Jun 1978. Contract EE-77-S-02-4318. 26p. Dep. NTIS, PC A03/MF A01.

Although the germanium-gallium generator is probably the only source of positron-emitting radionuclides that would enable the wide application of positron tomography, the generator system in use suffers from several major disadvantages. The most important of these is that the generator is eluted with EDTA, and EDTA forms a very strong chelate with gallium. In order to produce radiopharmaceuticals other than gallium-68 EDTA it is necessary to break the stable EDTA complex and remove all the EDTA. A new generator system using a solvent extraction system which will produce gallium-68 8-hydroxyquinoline, a weak chelate has been developed. Using this agent, several gallium-68 radiopharmaceuticals have been synthesized and tested in vitro and in vivo. Attempts have been made using polarographic and chromatographic techniques to investigate the stability of gallium-68 complexes with a series of cryptates.

COMBUSTION, PYROLYSIS, AND HIGH-TEMPERATURE CHEMISTRY

10442 (AD-A—064430) **In-situ measurements of gas species concentrations. Final technical report 15 Nov 76-15 Jun 78.** Chang, C.; Sides, G.D.; Tiernan, T.O. (Wright State Univ., Dayton, OH (USA)). Aug 1978. Contract F33615-76-C-2010. 91p. NTIS PC A05/MF A01.

This report gives the results of in-situ measurements of the concentrations of a simulated fuel (argon) in a dump combustor flow field, obtained using a sampling probe - mass spectrometer system. These data demonstrate the improved fuel-air mixing which is realized by utilizing specialized flame holders. The existence of swirl in the combustor flow field has also been established by these studies. The work described herein required more elaborate interfacing of the mass spectrometer with a gas calibration system which was designed, fabricated and tested during this reporting period. Several preliminary experiments were conducted using this gas calibration system, for the purpose of devising suitable methodology for detecting specific gas species of interest in connection with future combustion experiments. Calibration data and coefficients were obtained for the gases, methane, carbon dioxide and oxygen, and calibration data for water and carbon monoxide is presently being obtained. Some preliminary work was also accomplished in monitoring nitric oxide at the parts-per-million level, using the existing mass spectrometric diagnostic system. Finally, several experiments were conducted in sampling gaseous species from a Bunsen burner flame employing various types of sampling probes. (Author)

10443 (AD-A—064560) **Multiple ignition, normal and catalytic combustion and quenching of fuel/air mixtures. Interim report 1 Jun 77-31 May 78.** Bracco, F.V.; Homan, H.S.; Sirignano, W.A.; Santavicca, D.A. (Princeton Univ., NJ (USA). Dept. of Mechanical and Aerospace Engineering). Nov 1978. 24p. NTIS PC A02/MF A01.

Ignition of a quiescent propane/air mixture by a stationary, hot, inert particle has been modeled. The tentative conclusion from the model is that an abraded aluminum particle must have a diameter greater than 800 microns to ignite a stoichiometric propane/air mixture. Experimental data show that a burning aluminum particle must be initially larger than 20-40 microns in diameter to ignite a stoichiometric methane/air mixture. Lean combustion of propane in platinum/alumina/cordierite catalysts has been studied at atmospheric pressure and gas velocities of 5-30 m/s. Measurements of substrate temperature and gas composition, pressure and temperature inside and downstream of the catalyst have been made. The dependences of substrate temperature, gas temperature, and gas composition on inlet temperature, reference velocity, and equivalence ratio have been investigated. Homogeneous reactions in the exhaust are observed only at the higher equivalence rations. Broader interpretation of the variation in exhaust composition with inlet conditions awaits completion of the development of the numerical model. (Author)

10444 Two scaling transformations for the numerical computation of multidimensional unsteady laminar flames. O'Rourke, P.J.; Bracco, F.V. (Department of Mechanical and Aerospace Engineering, Princeton University, Princeton, New Jersey). EC-77-S-02-4191. *J. Comput. Phys.;* **33**: No. 2, 185-203(Nov 1979).

Numerical computations of the unsteady propagation of multidimensional laminar flames are difficult to perform because the structure of the flame must be resolved and the thickness of the flame is often several orders of magnitude smaller than the charac-

teristic dimension of the field. Two scaling transformations are discussed which make possible such computations by reducing the computation time to acceptable levels. The α-transformation is associated with the spatial uniformity of the time-varying pressure and is shown to be valid for low-Mach-number flows. It reduces computational time by either reducing the total number of time steps or, in the RICE code, the number of iterations required each time step. The β-transformation is related to the small thickness of the flame with respect to the characteristic dimension of the field and is shown to be useful for high Reynolds number flows. It reduces computation time by reducing the number of necessary grid points which, in turn, is achieved by broadening the flame front without altering the flame speed. The β-transformation was introduced by T. D. Butler and P. J. O'Rourke ("Proceedings, Sixteenth Symposium on Combustion, August 1976," pp. 1403—1516, The Combustion Institute, Pittsburgh, 1977). The validity of the two transformations is shown theoretically and through a series of computer calculations.

ENGINEERING

GENERAL ENGINEERING

REFER ALSO TO CITATION(S) 10642

FACILITIES AND EQUIPMENT

10445 (MLM—2682) **Crimping machine for the assembly of MC3347 and MC3352 isolators.** Gress, A.V. Jr. (Mound Facility, Miamisburg, OH (USA)). 10 Jan 1980. Contract EY-76-C-04-0053. 12p. Dep. NTIS, PC A02/MF A01.

A special lathe-type machine was designed and built to crimp the brass grounding cap to the steel spacer during the assembly of MC3347 and MC3352 isolators. The machine uses three rollers controlled by pneumatic and electronic circuitry to provide a semiautomatic cycle. All of the pressures and times associated with the operating parameters are adjustable and controllable.

10446 (PNL-SA—6870(Rev.)) **Description of a unique machine tool permitting achievement of < 15-A rms diamond-turned surfaces.** Miller, D.M.; Hauver, G.H.; Culverhouse, J.N.; Greenwell, E.N. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1980. Contract EY-76-C-06-1830. 12p. Dep. NTIS, PC A02/MF A01.

A new machine tool now in the final stages of development at the Pacific Northwest Laboratory uses a unique tool motion to produce diamond-turned surfaces of exceptionally high quality. The cutting tool is programmed to move in 4-nm increments along two axes: an X axis and an Omega axis. Exceptionally stiff and accurate control of the tool is possible with this Omega-X system. Copper surfaces of revolution have been produced with a 12.3-A rms surface finish and a contour accuracy of 75 nm. In conjunction with a unique, thermally stabilized air bearing spindle and machine calibration equipment, the Omega-X system permits a significant advance in the fabrication of optical-quality surfaces for use with the visible spectrum.

10447 Calorimeter for simultaneous, low-temperature measurements of energy release and of resistivity recovery in irradiated metals. Jackson, J.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Rev. Sci. Instrum.;* **51**: No. 1, 35-41(Jan 1980).

In this paper are described an irradiation calorimeter and data acquisition system used for simultaneous determinations of the rates of energy release and of resistivity recovery during anneals at low temperatures of irradiated metals. Both rates are measured on the same sample. The system provides efficient heat transfer from the specimen during irradiations and a good, reproducible degree of thermal isolation of the specimen during anneals. Necessary corrections to the raw data are discussed. The application of these measurements to determination of the energy released by interactions which immobilize self-interstitial atoms is described and illustrated by data from the recovery between 12 and 35 K of platinum irradiated with 20.6-MeV deuterons.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 10341, 10343, 10939

10448 (N—79-18266) **Electrical machines with superconducting field windings. Volume 1: turbugenerators. Final report.** Beck, K.; Boer, J.; Bogner, G.; Dham, R.; Henninger, P. (Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). Dec 1977. 367p. NTIS PC A16/MF A01.

The electrical and mechanical design of a 3000 MVA synchronous generator for 3000 r/min using superconducting field windings is described. Special attention is given to the rotor and the associated thermal and mechanical stress problems. The difficulties encountered are outlined. This machine is compared with a conventional 1500 MVA generator of approximately the same dimensions.

10449 Stability of cable-in-conduit superconductors. Lue, J.W.; Miller, J.R.; Dresner, L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **51**: No. 1, 772-783(Jan 1980).

The stability margin of a single triplex of NbTi/Cu strands soldered around a heater wire, sheathed in a stainless-steel tube, and cooled by pressurized helium is found to be multivalued for certain combinations of transport current, ambient helium pressure, and externally imposed helium flow. A qualitative model based on the idea that good recovery in stagnant or slowly flowing helium is due to heating-induced flow accounts well for the complex multivalued behavior of the stability margin.

HANDLING EQUIPMENT AND PROCEDURES

REFER ALSO TO CITATION(S) 10450

SHIPPING CONTAINERS

10450 (NUREG/CP—0001, pp 277-284) **Purification methods and packaging of tritium at Oak Ridge National Laboratory for distribution to commercial users.** Case, F.N. (Oak Ridge National Lab., TN). Aug 1978.

In Radioactivity in consumer products.

Tritium shipped from ORNL is purified just before shipment to minimize the amount of the ^{3}He decay product and atmospheric gas impurities. The purification process involves conversion of tritium to uranium tritide and is accomplished by reacting tritium gas with activated uranium metal powder in a closed system from which atmospheric gases have been removed. Cylinders that are determined to be leak free are connected to the purification system and tritium is loaded into them by heating the uranium tritide to approximately 500°C, at which temperature the tritium is released. The design of the shipping cylinder is discussed as well as the treatment of the cylinder prior to and after loading with tritium. (RJC)

LASERS

REFER ALSO TO CITATION(S) 10342

10451 (AD-A—070486) **Self-consistent theory of cyclotron maser instability for intense hollow electron beams.** Uhm, H.; Davidson, R.C.; Chu, K.R. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1978. Contracts N00014-75-C-0309;N00014-67-A-0239. 47p. NTIS PC A03/MF A01.

This paper develops a self-consistent theory of the cyclotron maser instability, assuming azimuthally symmetric perturbations about a slowly rotating hollow electron beam propagating parallel to a uniform axial magnetic field (B sub 0) (e sub z). The stability analysis is carried out within the framework of the linearized Vlasov-Maxwell equations. The analysis is carried out for the specific choice of equilibrium electron distribution function in which all electrons have the same value of canonical angular momentum and the same value of energy in a frame of reference moving with axial velocity c(beta sub b). Stability properties are investigated including the important influence of finite radial geometry, finite beam temperature, and transverse magnetic perturbations.

10452 (N—79-18308) **Studies of basic mechanisms occurring in high pressure gases: applications to high efficiency high power lasers. Final report.** Crane, J.K.; Verdeyen, J.T.; Cherrington, B.E. (Illinois Univ., Urbana (USA). Dept. of Electrical Engineering). 28 Feb 1979. Contract NGR-14-005-200. 31p. NTIS PC A03/MF A01.

The atomic fluorine laser was investigated. In the hollow cathode, lasing on fluorine transitions in the doublet system lasted for up to 80 microseconds with no signs of self-termination. The excitation process of the laser appears to depend heavily upon the fluorine donor utilized. For instance, a single step process is involved when NF3 is used whereas a two step process is evident for SF6. The details are discussed.

10453 (NTIS/PS—79/0823) **Dye lasers (citations from the International Aerospace Abstracts data base). Report for 1976-July 1979.** Mauk, S.C. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 55p. NTIS PC N01/MF N01.

This bibliography cites articles concerning continuous wave, pulsed, ultrashort pulsed, ultraviolet, and infrared dye lasers. Articles covering laser outputs, materials, and applications are stressed. (Contains 279 citations)

10454 (NTIS/PS—79/0839) **Gas dynamic lasers (a bibliography with abstracts). Report for 1964-July 1979.** Carrigan, B. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 256p. NTIS PC N01/MF N01.

The citations cover research on kinetic and energy transfer processes, design, optics, nozzles, and performance of gas and chemical lasers relying on gas dynamic effects for lasing enhancement. Diffusion and flow studies specifically applicable to such lasers are also included. (This updated bibliography contains 247 abstracts, 11 of which are new entries to the previous edition.)

10455 (PB—292245) **Optical materials characterization final technical report february 1, 1978-september 30, 1978. Technical note.** Feldman, A.; Horowitz, D.; Waxter, R.M.; Dodge, M.J. (National Bureau of Standards, Washington, DC (USA). Center for Materials Science). Feb 1979. 74p. NTIS PC A04/MF A01.

Data obtained as part of the Optical Materials Characterization Program are summarized in this report. Room temperature values of refractive index as a function of wavelength are presented for the following materials: commercially grown KCl, reactive atmosphere processed (RAP) KCl, KCl nominally doped with 1.5% KI, hot forged CaF2, fusion cast CaF2, CaF2 doped with Er (0.001% to 3% Er), SrF2, chemical vapor deposited (CVD) ZnSe (2 specimens), and ZnS (CVD, 2 specimens). Data for the thermo-optic constant (dn/dT) and the linear thermal expansion coefficient are given for the following materials over the temperature range -180 degrees C to 200 degrees C: Al2O3, BaF2, CaF2, CdF2, KBr, KCl, LiF, MgF2, NaCl, NaF, SrF2, ZnS (CVD), and ZnSe (CVD). The piezo-optic constants of the following materials are presented: As2S3 glass, CaF2, BaF2, Ge, KCl, fused SiO2, SrF2, a chalcogenide glass (Ge 33%, As 12%, Se 55%) and ZnSe (CVD).

10456 Master oscillator power amplifier experiment for the determination of the gain coefficient and saturation intensity for an electron-beam-excited KrF amplifier. Patterson, E.L.; Rice, J.K.; Tisone, G.C. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Appl. Phys. Lett.;* **36**: No. 3, 188-190(1 Feb 1980).

A master oscillator power amplifier (MOPA) experiment using an electron-beam-excited KrF oscillator and amplifier is described. The amplifier gain as a function of input intensity is determined. A comparison of the measured gain with calculations using a steady-state analysis yields a determination of the small-signal gain coefficient and saturation intensity for the amplifier operating with two different gas mixtures. The small-signal gain is found to be more than an order of magnitude larger than the nonsaturable loss, indicating that efficient energy extraction from the amplifier is possible under the high excitation conditions (1.5—6 MW/cm^3) of this study.

10457 Picosecond transverse-flow flashlamp-pumped dye laser. Woodruff, S.D.; Prybyla, S.G.; Struve, W.S. (Iowa State University, Chemistry Department, Ames, Iowa 50011). W-7405-ENG-82. *Appl. Opt.;* **19**: No. 1, 118-123(1 Jan 1980).

Tunable bandwidth-limited light pulses exhibiting ~3-psec FWHM duration and 2—7μJ/pulse have been obtained at repetition rates up to ~5 Hz with good mode-locking quality in a transverse-flow flashlamp-pumped rhodamine 590 laser mode-locked with 3,3'-diethyl-oxadicarbocyanine iodide (DODCI). The present picosecond laser design can be extended to higher repetition rates, pulse energies, and everage powers.

10458 Profile of a focussed collimated laser beam near the focal minimum characterized by fluorescence correlation spectroscopy. Sorscher, S.M.; Klein, M.P. (Laboratory of Chemical Biodynamics, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **51**: No. 1, 98-102(Jan 1980).

Central to the application of fluorescence correlation spectroscopy, to measure the self-diffusion coefficients and average concentration of fluorescent molecules in a volume determined by a focussed laser beam, is the determination of the focal spot size. As the focal spot size in the sample plane is varied by displacing either the focusing lens or sample position along the beam axis, the diffusion time and average number of molecules vary in a parabolic manner. Analysis of the parameters of the parabola leads to estimates of the beam radius at the waist. The results agree with theoretical predictions and provide an independent measurement of the beam profile.

10459 Effects of chemical kinetics of the performance of the atomic iodine laser system. Fisk, G.A.; Truby, F.K. (Sandia Laboratories, Albuquerque, New Mexico 87185). *J. Appl. Phys.;* **51**: No. 1, 94-101(Jan 1980).

Model calculations show that chemical reactions which take place in the active medium of a photolytically pumped iodine laser limit the efficiency with which pump photons are utilized and convert significant amounts of the starting material RI to the unwanted by-products R_2 and I_2. Laser- and rf-discharge-based methods for regenerating starting materials from by-products are evaluated experimentally. For economical operation of large iodine laser systems, CF_3I is presently the best starting material, and a pulsed rf-discharge technique is presently the best one for chemical regeneration. The absorbed energy required to regenerate one CF_3I molecule using pulsed rf-discharge techniques is 5.8 eV.

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 9578

10460 Freezing controlled by natural convection. Sparrow, E.M.; Ramsey, J.W.; Kemink, R.G. (Department of Mechanical Engineering, University of Minnesota Minneapolis, Minn, 55455). DE-AS-0279ER10343.A000. *J. Heat Transfer;* **101**: No. 4, 578-584(Nov 1979).

Experiments were performed for freezing under conditions where the liquid phase is either above or at the fusion temperature (i.e., superheated or nonsuperheated liquid). The liquid was housed in a cylindrical containment vessel whose surface was maintained at a uniform, time-invariant temperature during a data run, and the freezing occurred on a cooled vertical tube positioned along the axis of the vessel. The phase change medium was n-eicosane, a paraffin which freezes at about 36°C (97°F). In the presence of liquid superheating, the freezing process is drastically slowed and ultimately terminated by the natural convection in the liquid. The terminal size of the frozen layer an the time at which freezing terminates can be controlled by setting the temperature parameters which govern the intensity of the natural convection. The stronger the natural convection, the thinner the frozen layer an the shorter the freezing time. In the absence of liquid superheating, a cylindrical frozen layer grows continuously as predicted by theory, but the growth rate is higher than the predictions because of the presence of whisker-like dendrites on the freezing surface.

10461 Natural convection heat transfer in moderate aspect ratio enclosures. Meyer, B.A.; Mitchell, J.W.; El-Wakil, M.M. (Mechanical Engineering Department, The University of Wisconsin, Madison, Wisc. 53706). E(11-1)-2941. *J. Heat Transfer;* **101**: No. 4, 655-659(Nov 1979).

Local and average heat transfer coefficients for natural convection between parallel plates separated by slats to create enclosures of moderate aspect ratio have been experimentally determined using an interferometric technique. The effects of Rayleigh number, tilt and slat angle, and aspect ratio on the Nusselt number have been determined. The Rayleigh number range tested was up to 7 x 10^4, and the aspect ratio (ratio of enclosure length to plate spacing) varied between 0.25 and 4. The angles of tilt of the enclosure with respect to the horizontal were 45, 60 and 90 deg. Slat angles of 45, 60 90 and 135 deg were studied. The results obtained in a previous investigation [1] for aspect ratios of 9 to 36 are included to show continuity. The results indicate that the convective heat transfer is a strong function of the aspect ratio for aspect ratios less than 4. For aspect ratios in the range of 0.5 to 4, spacers between the plates increase, rather than decrease, natural convection heat transfer compared to that for long enclosures. Slat angles less than 90 deg (i.e., oriented downward) reduce convective heat transfer.

10462 Melting about a horizontal row of heating cylinders. Ramsey, J.W.; Sparrow, E.M.; Varejao, L.M.C. (Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. 55455). DE-AS0279ER10343.A000. *J. Heat Transfer;* **101**: No. 4, 732-733(Nov 1979).

Melting coefficients are obtained for an array of heating cylinders embedded in a eutectic mixture of $NaNO_4$ and NaOH. (AIP)

MATERIALS TESTING

REFER ALSO TO CITATION(S) 10083, 10491

10463 (SAND—79-8054) **Technical manual: primary data reduction programs for the Eclipse S-200/230 shock and vibration measurement systems.** Swan, H.W. (Sandia Labs., Livermore, CA (USA)). Nov 1979. Contract EY-76-C-04-0789. 41p. Dep. NTIS, PC A03/MF A01.

This document describes the internal workings and computational algorithms for the quick-look plotting programs and primary data reduction programs for the Eclipse computer-based shock and vibration test centers. This information supplements operational descriptions of these programs, given in Sandia Laboratories reports SAND79-8053 and SAND79-8055. 9 figures, 1 table.

ELECTRONIC CIRCUITS AND DEVICES

10464 (LA—8069-PR) **E-Division semiannual report, January 1-June 30, 1979.** Kelley, P.A. (comp.). (Los Alamos Scientific Lab.,

NM (USA)). Nov 1979. Contract W-7405-ENG-36. 90p. Dep. NTIS, PC A05/MF A01.

The status of the programs and projects of the Electronics Division for the period January through June 1979 is reported. The presentation is divided into three sections: Research, Engineering Support, and Technical Services. Each of these sections presents the activities and accomplishments of the corresponding branch within the Division. The primary goal of the Research and Development branch is to advance technology for future applications. The primary goal of the Engineering Support branch is to apply advanced technology to Laboratory and material problems. The primary goal of the Technical Services branch is to provide a technical base and support for Laboratory programs. These goals are reflected in the report.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 9562, 9564, 9617, 9618, 9670

10465 (DOE/FE/2461—13) **Industrial application of fluidized-bed combustion. Quarterly technical progress report, July-September 1979.** (Georgetown Univ., Washington, DC (USA)). Dec 1979. Contract EX-76-C-01-2461. 51p. Dep. NTIS, PC A04/MF A01.

Plant startup operations were initiated on July 9, 1979 with the successful completion of a scheduled boiler lightoff followed by 8 hours of steam generation and a scheduled shutdown. A total of 9 separate coal-fired operations were completed during which steam was generated and delivered to the Georgetown University (GU) header for a total of 213 hours. The longest sustained operation was 66 hours. Initial operations were performed burning low sulfur (< 1% S) coal. Subsequently, as light-off techniques became established, the bulk of the boiler operations were conducted with high sulfur (2 to 4% S) coal. All operations, with the exception of 1 1/2 hours, were conducted on Bed A only of the two bed AFB. The average rate of steam generation during the reporting period was about 35,000 lbs/hr with minimum and peak generation rates of 28,000 to 60,000 lbs/hr. During the brief 1 1/2 hour operation on two beds, the steam generation rate reached a maximum of 60,000 lbs/hr. Operation at higher generation rates will be dependent upon cooler weather conditions and the attendant increase in campus steam consumption. Time between boiler operations was spent in correcting equipment malfunctions, performing final adjustments, instituting minor plant modifications, and evaluating equipment performance. Stack emissions of SO_2, NO/sub x/ and particulates were controlled well within the District of Columbia emissions standards during periods of boiler operations.

POLLUTION CONTROL EQUIPMENT

10466 (PB—292820) **Characterization of the EPA/IERL-RTP pilot-scale precipitator. Report for Sep 77—May 78.** Lawless, P.A.; Daniel, B.E.; Ramsey, G.H. (Environmental Protection Agency, Research Triangle Park, NC (USA). Industrial Environmental Research Lab.; Research Triangle Inst., Research Triangle Park, NC (USA)). Feb 1979. 86p. NTIS PC A05/MF A01.

The report describes the EPA/IERL-RTP pilot scale electrostatic precipitator, a research device used for testing and verifying new precipitator concepts and models of precipitator operation. It describes the basic capabilities of the precipitator, and contains measurements of precipitator operating characteristics which were obtained in the first months of investigation. The precipitator performed to its design specifications in initial tests, and its utility as a research tool was quickly established. Several proposed experiments which will be performed on the precipitator are described.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

10467 **Hyperon beam physics.** Lach, J.; Pondrom, L. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Annu. Rev. Nucl. Sci.;* **29**: No. 1, 203-242(Dec 1979).

The production and uses of hyperon beams are discussed. Result, from the Fermilab and CERN facilities are considered in detail. (AIP)

AUXILIARIES AND COMPONENTS

ION SOURCES

10468 (BNL—26894) **Autoconditioning system for BNL negative ion sources.** Larson, R.A. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 3p. (CONF-791102—85). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The autoconditioning system at BNL is being used to condition negative ion sources now under development. A minicomputer with appropriate interface hardware is employed to implement simple algorithims, slowly increasing the operating point of the source. This paper gives a brief description of the hardware and the software system.

EXPERIMENTAL FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 10757, 10927

10469 (BNL—26951) **Linear accelerator fuel enricher regenerator (LAFER) and fission product transmutor (APEX).** Steinberg, M.; Powell, J.R.; Takahashi, H.; Grand, P.; Kouts, H.J.C. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 20p. (CONF-791204—15). Dep. NTIS, PC A02/MF A01.

From 2. Miami international conference on alternative energy sources; Miami Beach, FL, USA (10 Dec 1979).

In addition to safety, two other major problems face the nuclear industry today; first is the long-term supply of fissle material and second is the disposal of long-lived fission product waste. The higher energy proton linear accelerator can assist in the solution of each of these problems. High energy protons from the linear accelerator interact with a molten lead target to produce spallation and evaporation neutrons. The neutrons are absorbed in a surrounding blanket of light water power reactor (LWR) fuel elements to produce fissile Pu-239 or U-233 fuel from natural fertile U-238 or Th-232 contained in the elements. The fissile enriched fuel element is used in the LWR power reactor until its reactivity is reduced after which the element is regenerated in the linear accelerator target/blanket assembly and then the element is once again burned (fissioned) in the power LWR. In this manner the natural uranium fuel resource can supply an expanding nuclear power reactor economy without the need for fuel reprocessing, thus satisfying the US policy of non-proliferation. In addition, the quantity of spent fuel elements for long-term disposal is reduced in proportion to the number of fuel regeneration cycles through the accelerator. The limiting factor for in-situ regeneration is the burnup damage to the fuel cladding material. A 300 ma-1.5 GeV (450 MW) proton linear accelerator can produce approximately one ton of fissile (Pu-239) material annually which is enough to supply fuel to three 1000 MW(e) LWR power reactors. With two cycles of enriching and regenerating, the nuclear fuel natural resource can be stretched by a factor of 3.6 compared to present fuel cycle practice without the need for reprocessing. Furthermore, the need for isotopic enrichment facilities is drastically reduced.

10470 (CONF-790847—15) **Improved kaon beam and spectrometer for the AGS.** Hungerford, E.V. III. (Houston Univ., TX (USA)). 1979. Contract EY-76-S-05-3948. 7p. Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

The properties of the existing low energy separated kaon beams at the Brookhaven AGS, and the preliminary plans to construct an improved kaon beam line with a high resolution spectrometer for this facility are reported. 10 references.

10471 (CONF-7910119—1) **Heavy ion stripping by wrinkled carbon foils.** Den Hartog, P.K.; Yntema, J.L.; Thomas, G.E.; Henning, W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 17p. Dep. NTIS, PC A02/MF A01.

From 8. annual conference of the I.N.T.D.S.; Boston, MA, USA (1 Oct 1979).

The use of mechanically slackened, or wrinkled, foils as stripper foils in the tandem electrostatic accelerator is discussed as a means of increasing foil life is discussed. Performance of such foils is shown. (GHT)

10472 (SAND—79-1945C) **Experimental investigations of high current linear ion accelerators.** Humphries, S. Jr. (Sandia Labs., Albuquerque, NM (USA)). 1980. Contract EY-76-C-04-0789. 3p. (CONF-800208—3). Dep. NTIS, PC A02/MF A01.

From Tropical meeting on inertial confinement fusion; San Diego, CA, USA (26 Feb 1980).

Experiments on high current pulsed linear ion accelerators are described. A five-stage device, Pulselac B, has produced 4 kA of C+ at 700 keV for a 0.5 microsecond pulse.

10473 (SLAC-PUB—2425) **Results from the crystal ball detector at SPEAR.** Bloom, E.D. (Stanford Univ., CA (USA)). Nov 1979. Contract EY-76-C-03-0515. 14p. (CONF-790885—12). Dep. NTIS, PC A02/MF A01.

From 9. international symposium on lepton and photon interactions at high energy; Batavia, IL, USA (23 Aug 1979).

The Crystal Ball detector is a device particularly suited to the measurement of photons with energies lower than 1 GeV. The detector has as its principal component a 16 radiation length thick, highly segmented shell of NaI(Tl) surrounding cylindrical, proportional, and magnetostrictive spark chambers. The main Ball and various elements of the central chambers cover 94% of 4π sr. Segmented endcap NaI(Tl) detectors of 20 radiation lengths behind magneto strictive spark chambers supplement the main Ball. The Ball and endcaps close the solid angle for charged particle and photon detection to 98% of 4π sr. In addition, detectors of interspersed iron and proportional tubes provide for μ-π separation over 15% of 4π sr, about θ/sub CM/ = 90°. In this report preliminary results are presented from the data obtained. In particular, QED at E/sub CM/ = 6.5 GeV, R/sub hadron/ and related inclusive distributions, eta branching fractions at J/psi and psi", and a detailed study of the psionium system are discussed.

10474 **Pulsed spallation neutron sources.** Carpenter, J.M.; Blewitt, T.H.; Price, D.L.; Werner, S.A. (Argonne National Laboratory). *Phys. Today;* **32**: No. 12, 42-49(Dec 1979).

These new, intense neutron sources take up where high-flux reactors leave off, making possible a host of new structural and dynamic studies as well as neutron-irradiation investigations.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 10501

10475 (CONF-791037—18) **Fully encapsulated directional self-powered gamma ray detector for use in in-core nuclear reactor measurements.** LeVert, F.E.; Cox, S.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 5p. Dep. NTIS, PC A02/MF A01.

From IEEE nuclear science symposium; San Francisco, CA, USA (17 Oct 1979).

A study of a fully encapsulated directional self-powered gamma ray detector designed for localized in core measurements in a nuclear reactor was conducted. The detector consisted of a multilayer arrangement of a metal-dielectric-metal-dielectric-metal structure. The dielectric material was made of two plates of unequal thicknesses which were placed on opposite sides of the central metal plate. The direction discrimination exhibited by the detector was attributed to the combined effect of electron ranges, Photo-Compton electron generation rates, and the presence of E-fields in the unequal thicknesses of dielectric material. Results showing the response of the detector when it was placed in a gamma ray field with a known anisotropic component are presented.

10476 (COO—4197-T4) **Sodium ionization detector and sensor.** Hrizo, J.; Bauerle, J.E. (Westinghouse Research Labs., Pittsburgh, PA (USA)). 8 May 1979. Contract EN-77-C-02-4197. 50p. Dep. NTIS, PC A03/MF A01.

Work conducted on a basic technology development effort with the Westinghouse Sodium Ionization Detector (SID) sensor is reported. Included are results obtained for three task areas: (1) On-line operational response testing - in-situ calibration techniques; (2) Performance-reliability characteristics of aged filaments; and (3) Evaluation of chemical interference effects. The results showed that a calibrator filament coated with a sodium compound, when activated, does supply the necessary sodium atoms to provide a valid operational in-situ test. The life time of new Cr_2O_3-protected SID sensor filaments can be extended by operating at a reduced temperature. However, there also is a reduction in the sensitivity. Non-sodium species, such as products from a smoldering fire and organic aerosols, produce an interference response from the sensor comparable to a typical sodium response.

10477 **Coaxial nuclear radiation detector with deep junction and radial field gradient.** Hall, R.N. (to Dept. of Energy). US Patent 4,157,559. 5 Jun 1979. Filed date 31 Jan 1977. 8p.

PAT-APPL-763,836.

Germanium radiation detectors are manufactured by diffusion lithium into high purity p-type germanium. The diffusion is most readily accomplished from a lithium-lead-bismuth alloy at approximately 430° and is monitored by a quartz half cell containing a standard composition of this alloy. Detectors having n-type cores may be constructed by converting high purity p-type germanium to n-type by a lithium diffusion and subsequently diffusing some of the lithium back out through the surface to create a deep p-n junction. Coaxial germanium detectors comprising deep p-n junctions are produced by the lithium diffusion process.

10478 **Particle detection systems.** Enge, H.A. (Massachusetts Inst. of Tech., Cambridge). *IEEE Trans. Nucl. Sci.;* **NS-26**: No. 2, 2420-2426(Apr 1979).

A brief review is given of the most common nuclear particle detectors such as the gas ionization chamber, the surface barrier detector, and scintillation detectors. Some combinations of detectors are discussed with particular emphasis on heavy-ion spectroscopy. Magnetic (momentum) spectrographs and one example of a proposed energy-mass spectrograph complete the list. Some possible future trends are indicated.

10479 **Radiation detection system.** Franks, L.A.; Lutz, S.S.; Lyons, P.B. (to Dept. of Energy). US Patent Application 949,163. 6 Oct 1978. 20p.

A radiation detection system including a radiation-to-light converter and fiber optic wave guides to transmit the light to a remote location for processing is described. The system utilizes fluors particularly developed for use with optical fibers emitting at wavelengths greater than about 500 nm and having decay times less than about 10 ns.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 10660

10480 **Simplified fast neutron dosimeter.** Sohrabi, M. (to Dept. of Energy). US Patent 4,157,473. 5 Jun 1979. Filed date 8 Dec 1975. 8p.

PAT-APPL-638,899.

Direct fast-neutron-induced recoil and alpha particle tracks in polycarbonate films may be enlarged for direct visual observation and automated counting procedures employing electrochemical etching techniques. Electrochemical etching is, for example, carried out in a 28% KOH solution at room temperature by applying a 2000 V peak-to-peak voltage at 1 kHz frequency. Such recoil particle amplification can be used for the detection of wide neutron dose ranges from 1 mrad to 1000 rads or higher, if desired. 5 claims.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

REFER ALSO TO CITATION(S) 10478, 10570

10481 (COO—2184-47) **Nuclear Chemistry Project. Progress report, Janary 1, 1979-December 31, 1979.** (Princeton Univ., NJ (USA)). 21 Dec 1979. Contract EY-76-S-02-2184. 25p. Dep. NTIS, PC A02/MF A01.

The first on-line operation of the Princeton electron spectrometer was achieved and its capability for fast life time measurements demonstrated. The first operation of the heavy ion source was achieved and beams of 75 meV $^{12}C^{+4}$ ions and 37 MeV $^{6}Li^{+2}$ ions demonstrated. The capability of the isotope separator to provide pure mass separated samples of radioisotopes is being utilized for three different applications. The very weak electron capture branch of 19-s krypton 81m to bromine 81 was studied. This transition probability is of crucial importance for a possible solar neutrino detection method based on natural bromine. Lead 202 has been prepared and mass separated for optical hyperfine spectroscopic studies. The isotope shift shift which measures the second moment, $< r^2 >$, of the nuclear charge indicates the more neutron deficient lead isotopes are becoming increasingly soft toward nuclear deformation.

10482 (ORNL/TM—6342) **ORNL 10-m small-angle X-ray scattering camera.** Hendricks, R.W. (Oak Ridge National Lab., TN (USA)). Dec 1979. Contract W-7405-ENG-26. 162p. Dep. NTIS, PC A08/MF A01.

A new small-angle x-ray scattering camera utilizing a rotating anode x-ray source, crystal monochromatization of the incident beam, pinhole collimation, and a two-dimensional position-sensitive proportional counter was developed. The sample, and the resolution element of the detector are each approximately 1 x 1 mm², the camera was designed so that the focal spot-to-sample and sample-to-detector distances may each be varied in 0.5-m increments up to 5 m to provide a system resolution in the range 0.5 to 4.0 mrad. A large, general-purpose specimen chamber has been provided into which a wide variety of special-purpose specimen holders can be mounted. The detector has an active area of 200 x 200 mm and has up to 200 x 200 resolution elements. The data are recorded in the memory of a minicomputer by a high-speed interface which uses a microprocessor to map the position of an incident photon into an absolute minicomputer memory address. The data recorded in the computer memory

can be processed on-line by a variety of programs designed to enhance the user's interaction with the experiment. At the highest angular resolution (0.4 mrad), the flux incident on the specimen is 1.0 x 10^6 photons/s with the x-ray source operating at 45 kV and 100 mA. SAX and its associated programs OVF and MOT are high-priority, pre-queued, nonresident foreground tasks which run under the ModComp II MAX III operating system to provide complete user control of the ORNL 10-m small-angle x-ray scattering camera.

10483 Focal-surface detector for heavy ions. Erskine, J.R.; Braid, T.H.; Stoltzfus, J.C. (to Dept. of Energy). US Patent 4,150,290. 17 Apr 1979. Filed date 13 May 1977. 12p.

PAT-APPL-796,626.

A detector of the properties of individual charged particles in a beam includes a gridded ionization chamber, a cathode, a plurality of resistive-wire proportional counters, a plurality of anode sections, and means for controlling the composition and pressure of gas in the chamber. Signals generated in response to the passage of charged particles can be processed to identify the energy of the particles, their loss of energy per unit distance in an absorber, and their angle of incidence. In conjunction with a magnetic spectrograph, the signals can be used to identify particles and their state of charge. The detector is especially useful for analyzing beams of heavy ions, defined as ions of atomic mass greater than 10 atomic mass units. 7 claims.

10484 Small-angle electron scattering in the transmission electron microscope. Carpenter, R.W.; Bentley, J.; Kenik, E.A. (Oak Ridge National Lab., TN). *J. Appl. Crystallogr.;* **11**: 564-568(1978).

Two methods for performing small-angle electron scattering (SAES) experiments in transmission electron microscopes are described: the long-camera-length method and the selected-area-diffraction method. It is shown experimentally that angular resolutions of a few microradians and a few tenths of milliradians, respectively, are easily obtained by these two methods. A number of examples of the application of SAES to problems in materials science are presented. The use of new high-brightness electron sources is expected to produce significant increases in angular resolution, and the use of electron-energy analyzers will permit the separation of most of the inelastic contribution to the SAES intensity distribution.

HIGH ENERGY PHYSICS INSTRUMENTATION

REFER ALSO TO CITATION(S) 10473, 10754

10485 (BNL—26862) **Relativistic rise measurement by cluster counting method in time expansion chamber.** Rehak, P.; Walenta, A.H. (Brookhaven National Lab., Upton, NY (USA)). Oct 1979. Contract EY-76-C-02-0016. 6p. (CONF-791037—20). Dep. NTIS, PC A02/MF A01.

From IEEE nuclear science symposium; San Francisco, CA, USA (17 Oct 1979).

A new approach to the measurement of the ionization energy loss for the charged particle identification in the region of the relativistic rise was tested experimentally. The method consists of determining in a special drift chamber (TEC) the number of clusters of the primary ionization. The method gives almost the full relativistic rise and narrower landau distribution. The consequences for a practical detector are discussed.

RADIOMETRIC INSTRUMENTS

10486 X-ray inspection without film. Gehm, U. (Mueller (C.H.F.) G.m.b.H., Hamburg (Germany, F.R.)). pp 243-245 of Schweissen in der Kerntechnik. Duesseldorf, Germany, F.R.; Deutscher Verl. fuer Schweisstechnik (1978). (In German)

From 3. international colloquium on welding in nuclear engineering; Hamburg, F.R. Germany (28 Nov 1978).

The previous use of film wasted time, giving problems in stopping production to avoid wastage. The use of direct viewing systems (fluoroscopic screens and TV), detailed description, modulation, grid-resolution and frame frequency.

10487 Radiation attenuation gauge with magnetically coupled source. Wallace, S.A. (to Dept. of Energy). US Patent 4,095,106. 13 Jun 1978. Filed date 16 Mar 1977. 8p.

PAT-APPL-778,196.

Disclosed is a radiation attenuation gauge for measuring thickness and density of a material which includes, in combination, a source of gamma radiation contained within a housing of magnetic or ferromagnetic material, and a means for measuring the intensity of gamma radiation. The measuring means has an aperture and magnetic means disposed adjacent to the aperture for attracting and holding the housed source in position before the aperture. The material to be measured is placed between the source and the measuring means.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

REFER ALSO TO CITATION(S) 10504

10488 (BNL—26850) **Fast neutron damage in germanium detectors.** Kraner, H.W. (Brookhaven National Lab., Upton, NY (USA)). Oct 1979. Contract EY-76-C-02-0016. 25p. (CONF-791037—19). Dep. NTIS, PC A02/MF A01.

From IEEE nuclear science symposium; San Francisco, CA, USA (17 Oct 1979).

The effects of fast neutron radiation damage on the performance of both Ge(Li) and Ge(HP) detectors have been studied during the past decade and will be summarized. A review of the interaction processes leading to the defect structures causing trapping will be made. The neutron energy dependence of observable damage effects will be considered in terms of interaction and defect production cross sections.

MISCELLANEOUS INSTRUMENTS

10489 (PNL-SA—6895) **Distributed data analysis in a mobile real time and minicomputer network environment.** Thomas, J.J.; Sandness, G.A.; Schroeder, J.O.; Boland, A.J. (Battelle Pacific Northwest Labs., Richland, WA (USA)). 1978. Contract EY-76-C-06-1830. 10p. Dep. NTIS, PC A02/MF A01.

The system design and analysis processes involved in collecting data from a mobile laboratory to a finished analysis are presented. This involves real-time data collection on a small mobile cart, an intermediate analysis station in a nearby mobile van, and the final analysis performed through a minicomputer network of facilities. An iterative approach to data collection and review was established to provide timely analysis and verification of incoming data. This requires a highly interactive user-oriented environment in the field. After the data have been collected and preliminary analysis has been completed, the results can be integrated into a larger analysis system through a minicomputer network. This procedure also allows for utilization of high-cost equipment that cannot be placed in the field. A single hardware interface, BATNET (Battelle Network), is used to perform all data transfers via either radio (cart-to-van) or external network connections (van-to-computer network). The key software components described are a self-describing data base system utilizing simple relational data base concepts, a simple command language allowing analysis and investigation in the field, and a simple preview system for intensity-modulated data. 2 figures.

10490 (UNI—1405) **Ultrasonic flowmeters.** Wittekind, W.D. (United Nuclear Industries, Inc., Richland, WA (USA)). 12 Nov 1979. Contract EY-76-C-06-1857. 58p. Dep. NTIS, PC A04/MF A01.

A prototype ultrasonic flowmeter was assembled and tested. The theoretical basis of this prototype ultrasonic flowmeter is reviewed; the equipment requirements for a portable unit are discussed; the individual electronic modules contained in the prototype are described; the operating procedures and configuration are explained; and the data from preliminary calibrations are presented. The calibration data confirm that the prototype operates according to theoretical predictions and can indeed provide nonintrusive flow measurements to predicted accuracies for pipes larger than two inches, under single phase stable flow conditions.

10491 (Y/DW—2) **Automatic noise-blanking, pulse-timing discriminator for ultrasonic nondestructive testing.** Duncan, M.G. (Oak Ridge Y-12 Plant, TN (USA)). 1979. Contract W-7405-ENG-26. 8p. (CONF-7909109—2). Dep. NTIS, PC A02/MF A01.

From Ultrasonics Symposium; New Orleans, LA, USA (26 Sep 1979).

A new, easy to operate, pulse-timing discriminator has been developed for production inspection of parts. This instrument combines the noise-blanking advantages of threshold discrimination with the echo-timing precision of zero-crossing discrimination by using a shaped threshold detector output to enable a zero-crossng discriminator only when the RF ultrasonic signal exceeds an adjustable threshold. Flip-flops are then used to separate the echoes. Discriminator timing walk for a 30-dB amplitude change of a 5-MHz transducer waveform is only 200 psec, while timing jitter is only 30 psec. Long-term timing stability is 100 psec. In thickness gaging, a 200-psec timing error corresponds to an error of 0.64 micrometer in aluminum. An automatic polarity selection system corrects for pulse polarity inversions A time-to-pulse-height converter allows operation as a B-scan instrument capable of detecting flaws at depths of 0.25 mm in aluminum.

10492 Retractable, rear viewing low energy electron diffraction/ Auger spectroscopy system. Wendelken, J.F.; Withrow, S.P.; Herrell, P.S. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Rev. Sci. Instrum.;* **51**: No. 2, 255-258(Feb 1980).

The design of a rear viewing, retractable low energy electron diffraction assembly is described.

10493 Precision stress measurements in severe shock-wave environments with low-impedance manganin gauges. Vantine, H.; Chan, J.; Erickson, L.; Janzen, J.; Weingart, R.; Lee, R. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Rev. Sci. Instrum.;* **51**: No. 1, 116-122(Jan 1980).

We describe new techniques that permit the use of low-impedance manganin stress gauges in chemically reacting shock waves in the 1.0—40.0 GPa range. The rugged, small, and fast response gauge has reproducibility better than 2% when used in conjunction with a pulsed bridge circuit and adjustable, current-regulated power supplies. Techniques are presented for fabricating the transducer package, calibrating the bridge circuit and oscilloscopes, designing the drive system, and reducing the data. Data are presented for planar impact experiments performed with a 102-mm gas gun on high-explosive samples. In particular, we directly measured the Chapman-Jouquet pressure in the explosive RX03-BB [92.5% triaminotrinitrobenzene (TATB)/7.5% polychlorotrifluoroethylene (Kel-F binder)] as 28.2 +- 0.6 GPa. These new developments open the possibility of applying low-impedance manganin gauges in chemically reactive hydrodynamic flows such as the evolution of a shock wave into a detonation wave.

10494 Nondestructive acoustic electric field probe. Migliori, A.; Thompson, J.D. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **51**: No. 1, 479-485(Jan 1980).

A new method is described for the nondestructive measurement of electric field and space-charge distributions inside solid or liquid insulators by using a nonstructured acoustic pulse. The integral equation is derived for the response of the dielectric during propagation of an acoustic pulse and some acoustic measurements of electric fields and space charge inside transformer oil and polymethylmethacrylate plastic are described.

10495 Device for measuring the fluid density of a two-phase mixture. Cole, J.H. (to Dept. of Energy). US Patent Application 957,618. 30 Nov 1978. 10p.

A device is described for measuring the fluid density of a two-phase mixture flowing through a tubular member. A rotor assembly is rotatively supported within the tubular member so that it can also move axially within the tubular member. The rotor assembly is balanced against a pair of springs which exert an axial force in the opposite direction upon the rotor assembly. As a two-phase mixture flows through the tubular member it contacts the rotor assembly causing it to rotate about its axis. The rotor assembly is forced against and partially compresses the springs. Means are provided to measure the rotational speed of the rotor assembly and the linear displacement of the rotor assembly. From these measurements the fluid density of the two-phase mixture is calculated.

10496 Automatic sweep circuit. Keefe, D.J. (to Dept. of Energy). US Patent Application 961,153. 16 Nov 1978. 11p.

An automatically sweeping circuit for searching for an evoked response in an output signal in time with respect to a trigger input. Digital counters are used to activate a detector at precise intervals, and monitoring is repeated for statistical accuracy. If the response is not found then a different time window is examined until the signal is found.

10497 Microprocessor-based controller for nuclear instruments. Byrd, J.S. (du Pont de Nemours (E.I.) and Co., Aiken, SC). *IEEE Trans. Nucl. Sci.;* **NS-25**: No. 5, 1106-1110(Oct 1978).

A microprocessor-based digital controller was developed to control the operational modes and the data output of a nuclear PHA (pulse height analyzer). The controller communicates with the PHA via a full duplex serial communications line. Only four wires are required between the devices; therefore, this method is very desirable for remote applications when the nuclear detector and PHA may be distantly located from the controller. The I/O (input/output) device for the controller is a standard 110-baud keyboard terminal or a 2400-baud interface. A SC/MP-II (Simple Cost-effective Micro-Processor) with firmware (permanent software) provides the control functions and output data formatting. The firmware may be eaily changed to control other instruments.

10498 Martin-Puplett interferometer: an analysis. Lambert, D.K.; Richards, P.L. (Univ. of California, Berkeley). *Appl. Opt.;* **17**: No. 10, 1595-1602(15 May 1978).

A detailed analysis is presented of the Michelson polarizing interferometer suggested by Martin and Puplett. This instrument has many favorable properties for use as a far ir Fourier spectrometer. The effect of misalignments and imperfections of the optical components on the instrumental performance is calculated. Based on these results, we give a method of aligning the interferometer which optimizes its performance. In addition, this instrument may be used to measure the optical transfer function of a component in the output beam as a function of both spatial and optical frequency. A procedure is described by which this may be done.

10499 Composite bolometers for submillimeter wavelengths. Nishioka, N.S.; Richards, P.L.; Woody, D.P. (Univ. of California, Berkeley). *Appl. Opt.;* **17**: No. 10, 1562-1567(15 May 1978).

The fabrication and optimization of composite submillimeter wave bolometers with metal film absorbing elements and doped Ge thermometers are described. Performance characteristics are given for 4 x 4-mm bolometers designed for operation at both ^{4}He and ^{3}He temperatures. The performance expected from such bolometers when they are optimized for various values of background loading is calculated. Current dependent noise, which can arise from any of several sources, is included in the analysis. This can make it impossible to reach the background fluctuation noise limit. Feed structures for these bolometers which employ Winston light concentrators are described.

10500 (DOE/TIC—11043) Method of strain measurement and control used in fatigue and creep-fatigue tests performed in sodium at ANL. (Argonne National Lab., IL (USA)). [nd]. Contract W-31-109-ENG-38. 10p. Dep. NTIS, PC A02/MF A01.

The facility for conducting fatigue and creep fatigue tests in flowing sodium is described. It consists of a closed-loop servohydraulic fatigue machine with an associated sodium loop. Fatigue tests are conducted in a stroke-control mode using a standard resistive-type extensometer. (FS)

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 10009

10501 Subthreshold neutron interrogator for detection of radioactive materials. Evans, M.L.; Menlove, H.O.; Baker, M.P. (to Dept. of Energy). US Patent Application 948,266. 3 Oct 1978. 7p.

A device is described for detecting fissionable material such as uranium in low concentrations by interrogating with photoneutrons at energy levels below 500 keV, and typically about 26 keV. Induced fast neutrons having energies above 500 keV by the interrogated fissionable material are detected by a liquid scintillator or recoil proportional counter which is sensitive to the induced fast neutrons. Since the induced fast neutrons are proportional to the concentration of fissionable material, detection of induced fast neutrons indicate concentration of the fissionable material.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

REFER ALSO TO CITATION(S) 10493

NUCLEAR

REFER ALSO TO CITATION(S) 10314

10502 (SAND—79-1002) Prediction of ground motion from nuclear weapons tests at NTS. Vortman, L.J. (Sandia Labs., Albuquerque, NM (USA)). Nov 1979. Contract EY-76-C-04-0789. 48p. Dep. NTIS, PC A03/MF A01.

Ground motion data from underground nuclear detonations during FY78 were added to data from earlier detonations; the data were used to formulate a tentative equation for predicting ground motion at the Nevada Test Site. Additional measurements to explore an unexplained seismic anomaly in Jackass Flats are described. Methods used in automatic processing of ground motion data are explained.

10503 (UCRL—52856) ISC events from 1964 to 1976 at and near the nuclear testing ground in Eastern Kazakhstan. Rodean, H.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Oct 1979. Contract W-7405-ENG-48. 60p. Dep. NTIS, PC A04/MF A01.

Seismic events from 1964 to 1976 at and near the Nuclear Testing Ground (NTG) in Eastern Kazakhstan was studied using data published by the International Seismological Center (ISC) in the United Kingdom. During this period, the ISC detected 129 events concentrated in three testing areas within the NTG. The

detection performance of the network of stations that reported to the ISC was estimated during these years, and used the performance assessment to estimate the number of events within a magnitude range that may have been missed by the ISC. In addition, the apparent origin times of these events was examined with respect to their identity (earthquake or explosion), the relations between errors of calculated origin time and location, the apparent Soviet practice for timing the detonation of explosions, and the geophysical significance of the mean origin times within the minute. The identity of event 760320 is considered on the basis of its ISC origin time and location, the results of studies by other investigators, and its location close to a major fault that is clearly visible in Landsat imagery.

WEAPONRY

REFER ALSO TO CITATION(S) 10660

10504 (UCRL—52771) **Approach to evaluating and implementing EMP protection requirements for communication centers.** Cabayan, H.S.; Deadrick, F.J.; Martin, L.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 May 1979. Contract W-7405-ENG-48. 20p. Dep. NTIS, PC A02/MF A01.

The problem of protecting communication centers against the threat of high-altitude nuclear electromagnetic pulses (EMP) has been examined. Because such EMP could damage components in an unprotected facility, an approach to develop a set of minimum requirements so that effective hardening procedures can be designed and implemented is described. The approach includes evaluation of currently recommended protection practices, cost analyses, and development of test requirements, plans, and facilities.

EXPLOSION DETECTION

10505 (AD-A—066325) **Study of selected events in the Pamirs in a seismic discrimination context. Technical report.** Sobel, P.A.; von Seggern, D.H.; Sweetser, E.I.; Rivers, D.W. (Teledyne Geotech, Alexandria, VA (USA). Seismic Data Lab.). 10 Oct 1977. Contract F08606-77-C-0014. 74p. NTIS, PC A04/MF A01.

Eleven earthquakes with low reported M sub s for their m sub b from the Northern Pamirs were examined in a seismic discrimination context. Seismograms from ALPA, LASA, NORSAR, the HGLP and the WWSSN stations were studied for source mechanism, M sub s-m sub b, corner frequency, pP, complexity, and spectral ratio. All the Parmir events can be identified as earthquakes when their characteristics are compared to those of Kazakh explosions. P-waves to NORSAR from these earthquakes exhibit very high frequency, and their spectral corner frequencies are not distinctly different from those of explosions.

10506 (AD-A—066735) **Narrow and broad region dispersion of long-period surface waves. Technical report No. 16.** Unger, R. (Texas Instruments, Inc., Dallas (USA)). 11 Oct 1978. Contract F08606-77-C-0004. 28p. NTIS, PC A03/MF A01.

Examples of both narrow and broad region dispersion analysis for long-period surface waves are presented. Narrow region dispersion analysis of Kuriles/Kamchatka earthquake signals recorded at Guam, by means of moving-window maximum entropy spectral analysis, indicates strong multipathing in the 3.0 to 4.5 km/sec group velocity range, causing poor polarization filter performance. In contrast, between 2.0 and 3.0 km/sec the signals are well defined, resulting in a good polarization filter response. The dispersion for this region seems quite diverse. Broad region dispersion models for the North American and Asian continents were generated using previously reported group velocity data for Nevada Test Site and Eastern Kazakh presumed nuclear explosion signals recorded at world-wide stations. These models facilitate frequency-dependent surface wave magnitude measurement.

10507 (AD-A—070051) **Analysis of the superposition of ground motions from a surface row-cratering experiment and single contained nuclear events. Final technical report, 1 October 1977-31 January 1979.** Lynch, R.D. (Computer Sciences Corp., Falls Church, VA (USA)). 31 Jan 1979. Contract F08606-78-C-0008,. 70p. NTIS PC A04/MF A01.

This report examines the seismic aspects of a Threshold Test Ban Treaty Evasion scenario in which a clandestine nuclear device is detonated in the environment of a Peaceful Nuclear Experiment (PNE) involving the simultaneous detonation of a near-surface, multiple nuclear device configuration. The yield, location, and detonation delay time of the clandestine event relative to the PNE are examined in terms of the constraints imposed by both on-site and far-field monitoring equipment. Seismic recordings from the near-surface multiple detonation event, Buggy I, are used for the PNE while seismic recordings for the clandestine event are obtained by yield scaling the ground motion recordings from single contained events having the appropriate source-to-receiver distance. These two classes of signals are superimposed to simulate the ground motion for an evasion scenario. Spectral information is obtained from the PNE and the superposition seismograms and then analyzed to quantify the effect caused by the clandestine event.

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 10538

10508 (DOE/EIA—0148/12(78)) **Winter energy data bulletin.** (Department of Energy, Washington, DC (USA). Energy Information Administration). 1 Dec 1978. 7p. Dep. NTIS, PC A02/MF A01.

Weekly report during the winter heating season displays statistics on fuel supply forecasts with a weather summary and outlook. National Weather Service maps show temperature and precipitation predictions for the United States with a city and regional chart to describe normal and above- and below-average accumulated heat degree-days. The fuel forecast section covers production and stocks of major energy sources. Narrative sections present highlights and trends. 4 tables, 5 graphs, 2 maps.

10509 (DP—1526, pp 17-20) **Effect of spatial variability of meteorological data on annual average air concentrations.** Pendergast, M.M. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The significance of spatial variability of meteorological data was evaluated using calculated and observed annual average air concentrations. The joint frequency distribution of wind velocity and stability measured at eight locations was used in a simple diffusion model recommended by the Nuclear Regulatory Commission to predict annual average air concentrations at SRP. The variability of meteorological data was evaluated using annual average air concentrations of ^{85}Kr calculated from data at the 62-m level of 8 meteorological towers. These calculated air concentrations were compared with observed concentrations of ^{85}Kr measured downwind from a source near the center of the plant. The model caused an overprediction of about a factor of three with a variability of about 50% among the eight locations examined. The linear correlation coefficients between calculated and observed concentration range between 0.73 and 0.96 depending upon tower location. The magnitude of the correlation coefficient showed no relationship between distance from the source release point and the amount of meteorological data used to represent the annual frequency distribution of wind and stability.

10510 (DP—1526, pp 33-41) **Monthly mean wind fields for the South Atlantic bight.** Weber, A.H. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Computer analysis of meteorological observations taken aboard ships passing through the area of the South Atlantic bight yielded a spatially and temporally consistent wind field. The wind observations for both a 10-y period (1964 to 1973) and an 18-y period (1945 to 1963) show essentially the same results.

10511 (DP—1526, pp 43-48) **Analysis of Z and σ/sub z/ for near ground releases of tracers in the atmosphere.** Weber, A.H. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Lagrangian similarity theory has been combined with statistical theory to make predictions about the rate of expansion of a plume release from ground level (Hunt, 1978). In neutral conditions the rate of growth of the plume's vertical dimension (σ/sub z/ or anti Z) was found to be proportional to $\exp(-bz^{1/2})$. This result is quite different than the usually adopted Gaussian plume growth, i.e., $\exp(-bz^{2.0})$, but is closer to the observational studies summarized by Pasquill (1974), which are close to $\exp(-bz^{1.5})$.

10512 (DP—1526, pp 79-86) **Modeling pollutant dispersion over irregular terrain with second moments and cubic splines.** Pepper, D.W.; Baker, A.J. (Univ. of Tennessee, Knoxville). Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A general three-dimensional numerical code was developed to predict pollutant releases when the terrain is irregular and mixing depth varies with time. Advection is calculated with the quasi-Lagrangian scheme of moment distribution within a cell volume. Three-dimensional diffusion is solved with cubic spline interpolation functions. Coordinate transformations and the time-splitting proce-

dure of fractional steps are used to solve the three-dimensional equation set. To ensure that the wind field is mass-consistent, a variational analysis is made with Lagrangian multipliers to adjust the interpolated velocity components throughout the solution domain.

10513 (DP—1526, pp 93-95) **Solution of coupled partial differential equations using a tri-tridiagonal solution algorithm.** Cooper, R.E. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A computer method was developed to solve systems of equations where there are three unknowns at each node point. The three unknowns are expressed as a coupled system of three equations, and in finite difference form each equation is tridiagonal. The result is a tri-tridiagonal system of equations which are solved by an algorithm obtained from von Rosenberg (1971). Test problem results were obtained which agree well with results in the literature.

10514 (DP—1526, pp 187-189) **Measurement of light penetration in a forest.** Murphy, C.E. Jr.; Suich, J.E. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Energy and water balance studies are being conducted at Savannah River Plant to help better understand vegetative cycling of air pollutants. A critical parameter for models of pollutant uptake is the surface area of the vegetation. Measurements of vegetation surface area by dissection and planimetry of vegetation parts are very time consuming. Therefore, it was decided to attempt to calculate the surface area from sunlight penetration measurements. The results of a single winter's measurements indicated that the needle surface area of a pine forest can be related to the light penetration.

10515 **Gaussian moment-conservation diffusion model.** Shannon, J.D. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, IL 60439). *J. Appl. Meteorol.;* **18**: No. 11, 1406-1414(Nov 1979).

A new method of solution of the advection-diffusion equation is developed; the key feature of the method is the approximate conservation of the zeroth, first and second moments of pollutant mass, with the assumption of Gaussian subgrid-scale distributions. Test cases used in evaluation of other numerical dispersion techniques are simulated with the Gaussian moment-conservation (GMC) model; the tests attempt to quantify numerical error and computation time requirements. The GMC technique is found to be computationally rapid and applicable to telescoping grid systems, and to model diffusion accurately. In a limited number of test cases, the GMC technique exhibits a phase speed lag of about 10%; with considerable pseudodiffusion and dispersion of short waves for the advective case when initial gradients are steep.

10516 **Comparison of several forms of eddy viscosity parameterization in a two-dimensional cloud model.** Tag, P.M.; Murray, F.W.; Koenig, L.R. (Naval Environmental Prediction Research Facility, Monterey, CA 93940). E(04-3)-1191. *J. Appl. Meteorol.;* **18**: No. 11, 1429-1441(Nov 1979).

A two-dimensional model is used to test the effects of using several forms of eddy viscosity parameterization to simulate subgrid-scale turbulence. A well-documented observation of a quasi-steady cumulus cloud which formed over a refinery is used for simulation and comparison. The control parameterization of eddy viscosity is one based on both the deformation and buoyancy fields. When compared to observations, this control run overestimates somewhat the liquid water contents and slightly underpredicts the vertical velocities. Parameterizations based on deformation alone, two-dimensional turbulence theory, and several constant values of eddy viscosity result in cloud simulations that are deficient primarily in their significant overprediction of liquid water content. These experiments confirm that a buoyancy term in the prescription of eddy viscosity is necessary when thermal instability plays an active role in the subgrid forcing.

10517 **Comparison of three methods for measuring mixing-layer height.** Coulter, R.L. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, IL 60439). *J. Appl. Meteorol.;* **18**: No. 11, 1495-1499(Nov 1979).

Temperature profile, lidar and sodar results for determination of mixing-layer heights during October 1977 are compared. While the overall agreement was good, systematic differences do appear, particularly in early morning and late afternoon between lidar and sodar results, when the lidar values are consistently higher than the sodar. Temperature profile values are consistently lower than the other two methods. These differences are due to the slightly different behavior of the sensed variables near the capping inversion. Aerosols and particulates mix to larger heights than the top of the adiabatic temperature profile, while temperature fluctuations exhibit an increase at a height above the top of the adiabatic temperature profile but below the maximum height of particulate mixing.

10518 **Carbon dioxide and climaxte.** Marland, G.; Rotty, R.M. (Institute for Energy Analysis, Oak Ridge Associated Universities, Oak Ridge, Tennessee). *Rev. Geophys. Space Phys.;* **17**: No. 4, 1813-1824(Oct 1979).

Literature on the possible impact of carbon dioxide emissions on global climate is reviewed. The aspects covered are the following: Man's impact on carbon cycle, natural carbon cycle and perturbations, climatic response to carbon dioxide and human responses to climate change.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9650, 10540, 10544, 10545, 10547, 10549, 10562, 10681

10519 (DOE/EDP—0062) **Environmental development plans for energy technology programs. Summary report.** (Department of Energy, Washington, DC (USA). Div. of Technology Assessments). Oct 1979. 110p. Dep. NTIS, PC A06/MF A01.

A review of 30 Environmental Development Plans (EDPs) prepared in 1979 covering the Department of Energy's programs in the solar, geothermal, conservation, fossil, and nuclear energy technology areas is presented. For each area, the key environmental, health, and safety concerns are identified, and the research required to resolve the concerns is discussed. Abbreviated milestones for technology and environmental activities are presented, and the completion dates for mandated environmental documents are summarized. A key concern among the solar technologies is the toxic nature of many heat transfer fluids, heat storage media, and manufacturing or process fluids. In the geothermal programs, the concerns are highly site-specific and vary from the control of low-level hydrogen sulfide gas emissions to land subsidence and water use conflicts. The control of respirable particulates and the identification of associated carcinogenic compounds are important concerns in conservation technology development, while the undefined health effects of strong magnetic and electric fields are also of concern. Fossil energy technologies exhibit the same concerns as solar and conservation programs but have the additional concerns related to the safe disposal of large quantities of mining and process wastes and spent shale and the adequate control of pollutants from fossil fuel conversion and combustion processes. For nuclear programs, public and occupational health risks inherent in the exposure to long-duration, low-level radiation and the effective decontamination and decommissioning of nuclear facilities and waste materials are central concerns. Concerns common to all technology areas include socio-economic impacts, competition for limited land and water resources due to large-scale construction and land use, safe disposal of toxic manufacturing wastes, and possible contamination of water resources from accidental spillage of hazardous chemicals during transport or accidents.

10520 (EML—363(App.), pp B.1-B.119) **Chemical composition of atmospheric deposition.** Feely, H.W.; Larsen, R.J. 1 Oct 1979.

In Environmental Measurements Laboratory environmental quarterly. Appendix.

Studies on the effects of changes in patterns of energy use upon the major element and trace element chemical composition of precipitation, dry deposition, and total deposition are reported. Samples of wet, dry, and total deposition are collected on a monthly basis at seven sites within the conterminous United States. The main objective is to gather data on the geographical differences and time trends in precipitation chemistry and in concentrations of pollutants in deposition. These will be related to changing rates of use of various fuels and especially to increasing rates of coal combustion. The pH and conductivity of each sample are measured. The sample is analyzed in duplicate for ten major constituents: Na^+, K^+, Ca^{+2}, Mg^{+2}, NH_4^+, SO_4^{-2}, NO_3^-, Cl^-, PO_4^{-3}, and HCO_3^-. About four times a year the samples are also measured in duplicate for ten trace metals: Al, Fe, Pb, V, Mn, Ni, Cr, Cd, Zn, and As. The analytical techniques used for each constituent are summarized. Data from each of the seven sites are tabulated.

10521 (EML—370, pp I.30-I.33) **Atmospheric carbon dioxide analysis.** White, C.G. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly, September 1 through December 1, 1979.

Activities to provide a system for measuring ambient atmospheric carbon dioxide concentrations were successfully completed. The validity of data obtained by nondispersive infrared analyses was demonstrated by results obtained from several intercomparison studies with more experienced laboratories.

10522 (EML—370(App.), pp B.1-B.119) **Chemical composition of atmospheric deposition. Appendix B.** Feely, H.W.; Larsen, R.J. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly.

The effects of changes in patterns of energy use upon the major element and trace element chemical composition of precipitation, dry deposition and total deposition are being studied. Samples of wet, dry and total deposition are collected on a monthly basis at seven sites within the conterminous United States. The main objective is to gather data on the geographical differences and time trends in precipitation chemistry and in concentrations of pollutants in deposition. Results of samples collected at sites during 1976 to 1979 are tabulated. The samples are analyzed for ten major constituents: Na^+, K^+, Ca^{+2}, Mg^{+2}, NH_4^+, SO_4^+, NO_3^-, Cl^-, PO_4^{-3} and HCO_3^-. About four times a year the samples are also measured in duplicate for ten trace metals, Al, Fe, Pb, V, Mn, Ni, Cr, Cd, Zn and As. The analytical techniques which are used for each constituent by the contractor are summarized.

10523 (N—79-18479) **Condensation-nuclei (aitken particle) measurement system used in NASA Global Atmospheri Sampling Program.** Nyland, T.W. (National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center). Feb 1979. 28p. NTIS PC A03/MF A01.

The condensation-nuclei (Aitken particle) measuring system used in the NASA Global Atmospheric Sampling Program is described. Included in the paper is a description of the condensation-nuclei monitor sensor, the pressurization system, and the Pollack-counter calibration system used to support the CN measurement. The monitor has a measurement range to 1000 CN/cm cubed and a noise level equivalent to 5 CN/cm cubed at flight altitudes between 6 and 13 km.

10524 (NTIS/PS—79/0791) **Chemical analysis of aerosols and airborne particulates. Volume 2. 1977-July, 1979 (a bibliography with abstracts). Report for 1977-July 1979.** Cavagnaro, D.M. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 147p. NTIS PC N01/MF N01.

This bibliography cites reports covering the chemical analysis and composition of aerosols and airborne particulate matter. It excludes those covering particle sampling techniques and size analysis. Some of the techniques that are described include chromatography, activation analysis, and spectroscopic analysis. (This bibliography contains 141 abstracts, 40 of which are new entries to the previous edition.)

10525 (NTIS/PS—79/0842) **Remote sensing applied to environmental pollution detection and management (a bibliography with abstracts). Report for 1964-July 1979.** Hundemann, A.S. (National Technical Information Service, Springfield, VA (USA)). Aug 1979. 176p. NTIS PC N01/MF N01.

Application of remote sensing methods to air, water, and noise pollution problems is discussed. Topic areas cover characteristics of dispersion and diffusion by which pollutants are transported, eutrophication of lakes, thermal discharges from electric power plants, outfalls from industrial plants, atmospheric aerosols under various meteorological conditions, monitoring of oil spills, and application of remote sensing to estuarian problems. (This updated bibliography contains 167 abstracts, 11 of which are new entries to the previous edition.)

10526 **Laboratory results on the spill of soluble, high density chemicals on water.** Thibodeaux, L.J.; Chang, L.K.; Harris, J.K.; Lewis, D.J.; Mourot, M.W. (Univ. of Arkansas, Fayetteville). pp 511-514 of Fourth joint conference on sensing of environmental pollutants. Washington, DC; American Chemical Society (1978).

From 4. joint conference on sensing of environmental pollutants; New Orleans, LA, USA (6 Nov 1977).

The spill of high density liquid chemicals into water is occurring with increased frequency. Assessing the potential hazards of spills will become an important aspect in planning water transportation. Mechanistic processes that occur in the water from the time the liquid enters until the on-bottom dissolution is completed are addressed. Laboratory observations of model spills in quiescent water have shown that break-up occurs as the liquid jet enters the water and that coalescence takes place upon the bottom to reduce the mass transfer interface. The bottom residing interface is a function of the mass spilled, density, interfacial tension, and container diameter. The dissolution mass transfer rate is dominated by the water velocity, and the quantity of interfacial area. Six model chemicals were employed in quiescent laboratory tanks and scale model river simulators. The results of this work will be to develop realistic quantitative models that will predict the in-stream chemical concentration and life-time of this class of spills.

10527 (PB—292380) **Chemical composition of exhaust particles from gas turbine engines. Final report Nov 76—Mar 78.** Robertson, D.J.; Elwood, J.H.; Groth, R.H. (Pratt and Whitney Aircraft, East Hartford, CT (USA). Commercial Products Div.). Feb 1979. Contract EPA-68-02-2458. 178p. NTIS PC A09/MF A01.

A program was conducted to chemically characterize particulate emissions from a current technology, high population, gas turbine engine. Attention was focused on polynuclear aromatic compounds, phenols, nitrosamines and total organics. Polynuclear aromatic hydrocarbons (PAH) were determined by HPLC, GC/MS and NMR techniques. Phenols and nitrosamines were isolated and then measured by gas chromatographic methods utilizing flame ionization detection and nitrogen detection. Total organics were determined by a backflush chromatographic procedure. The particulate matter was collected using a high capacity pumping system incorporating 293 mm diameter Teflon filters through which was passed up to 43 cu m of exhaust gas. Extraction of the organic matter was performed in a Soxhlet extractor using hexane. The engine was operated at idle, approach, climb and take-off power settings with low sulfur (0.007%S) and high sulfur (0.25%S) fuels. Most of the PAH were small 3-to-4 fused ring species. No nitrosamines were found and except in a few cases, at low levels, no phenols. PAH and total organic levels decreased with increasing power setting and were more concentrated in the exhaust from the low sulfur fuel. Less than 1% of the organic matter emitted from the engine was adsorbed on the particulate matter.

10528 (PB—292703) **Predictions of highway emissions by a second order closure model. Final report Mar 77—Mar 78.** Teske, M.E.; Lewellen, W.S. (Aeronautical Research Associates of Princeton, Inc., NJ (USA)). Feb 1979. Contract EPA-68-02-2285. 95p. NTIS PC A05/MF A01.

The dispersion of sulfur hexafluoride tracer and sulfate from automobile emissions in the immediate vicinity of a highway were estimated for conditions similar to those existing during the General Motors sulfate dispersion experiment conducted at a GM test track. A second-order closure model of turbulent transport in the planetary boundary layer was used to predict the steady-state dispersion under two conditions: with the mean wind and velocity component variances specified by the data or predicted with the aid of an automobile wake model. The GM measured wind data apparently suffered from low vertical velocity variance readings at the 1.5 meter height, and led to an overprediction of the SF6 levels by an average factor of 1.77 for the 18 tower collection points during the 15 test days. The correlation fell to 0.96 of the measured levels when the model also predicted the wind fields. The results indicate that close to the highway, buoyancy effects were small even in the critical case when the wind is light and aligned with the roadway.

10529 (PB—292749) **Stability evaluation of ambient concentrations of sulfur dioxide, nitric oxide, and nitrogen dioxide contained in compressed gas cylinders.** Bennett, B.I. (Environmental Protection Agency, Cincinnati, OH (USA). Environmental Monitoring and Support Lab.). Feb 1979. 33p. NTIS PC A03/MF A01.

Compressed gas samples of sub-part per million concentrations of sulfur dioxide, nitric oxide, and nitrogen dioxide were evaluated for long and short term stability. Except for several stainless steel tanks, the samples were contained in aluminum cylinders. A degree of stability was achieved over the short term, however, all of the samples were considered unstable over the term of the evaluations. Utilization of ambient level compressed gas samples may be considered where relative stability is required for no more than two or three months.

10530 (PB—292788) **Fundamentals in air quality. Implementation package.** Ertugrul, A.M.; Hammond, H.R. (Greiner Environmental Sciences, Inc., Baltimore, MD (USA)). Feb 1977. Contract DOT-FH-11-8908. 294p. NTIS PC A13/MF A01.

The Implementation Package presents a basic understanding of air quality fundamentals. The text focuses its attention specifically to highway related air pollution and procedures used in the highway air quality assessment process. It gives the historical background of the air pollution problem in the U.S. and the world leading up to the Clean Air Act. It presents the major pollutants with emphasis on highway related, and discusses pollutant classification, sources and the potential effect on man and his environment. Highway traffic impacts on ambient air quality are explained along with discussions of engine emissions and the transportation network. It discusses the Clean Air Act development and the implementation procedures related to the transportation problem. The concept, methods and requirements of air pollution analysis are extensively covered. The various factors required for analysis such as meteorology, emissions factors, background concentrations, site monitoring, etc., are defined and explained in detail. The book concludes with a presentation of guidelines for preparing a comprehensive air quality study report for a highway E.I.S.

10531 (PB—292893) **CAASE - computer assisted area source emissions gridding procedure. Software.** Mersch, J.B. (Environmental Protection Agency, Research Triangle Park, NC (USA). Monitoring and Data Analysis Div.). Mar 1978. mag taep. Source tape is in EBCDIC character set. Character set restricts preparation to 9 track one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions. Price includes documentation, PB-286 285.

Atmospheric dispersion modeling programs such as the Climatological Dispersion Model (CDM), Air Quality Display Model

(ACDM), and Implementation Planning Program (IPP) are among the most basic tools used for evaluation of air quality and State Implementation Plans (SIP's). Since emissions data comprise the most important input information for these models, any factor affecting the availability and completeness of the emissions data has a significant impact on the results of the modeling programs. Procedures for formatting emissions from point sources are well defined; however, area source emission data present problems. Usually the smallest geographic unit for which accurate primary data are available is the county. These data must be disaggregated and appropriately allocated to smaller areas to provide an adequately detailed input. The Computer Assisted Area Source Emissions (CAASE) gridding programs with associated subroutines containing automated gridding procedures provide an objective method for allocating county-level data to grid squares selected on the basis of demographic features and sized to give appropriate detail for input to air quality modeling programs. The first 5 files on this tape are the source code (Fortran) for the 5 programs, CAASE 1 through CAASE 5, that comprise the Computer Assisted Area Source Emissions Gridding Procedure. These files are written in card image format and coded in EBCDIC. File 6 contains data required when coordinate transformations from one UTM zone to another is necessary. File 7 containing U.S. county boundary coordinates is required input to the CAASE 2 program. Files 6 and 7 are coded in EBCDIC...Software Description: The program is written in the Fortran programming language for implementation on an IBM 370 computer using the OS operating system.

10532 (PB—292931) **Level 1 environmental assessment performance evaluation. Final report jun 77-oct 78.** Estes, E.D.; Smith, F.; Wagoner, D.E. (Research Triangle Inst., Research Triangle Park, NC (USA)). Feb 1979. Contract EPA-68-02-2612. 174p. NTIS PC A08/MF A01.

The report gives results of a two-phased evaluation of Level 1 environmental assessment procedures. Results from Phase I, a field evaluation of the Source Assessment Sampling System (SASS), showed that the SASS train performed well within the desired factor of 3 Level 1 accuracy limit. Three sample runs were made with two SASS trains sampling simultaneously and from approximately the same sampling point in a horizontal duct. A Method-5 train was used to estimate the 'true' particulate loading. The sampling systems were upstream of the control devices to ensure collection of sufficient material for comparison of total particulate, particle size distribution, organic classes, and trace elements. Phase II consisted of providing each of three organizations with three types of control samples to challenge the spectrum of Level 1 analytical procedures: an artificial sample in methylene chloride, an artificial sample on a flyash matrix, and a real sample composed of the combined XAD-2 resin extracts from all Phase I runs. Phase II results showed that when the Level 1 analytical procedures are carefully applied, data of acceptable accuracy is obtained. Estimates of intralaboratory and interlaboratory precision are made.

10533 (PNL-SA—6679) **Experimental design for a case study of drift from a mechanical draft cooling tower.** Laulainen, N.S. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Apr 1978. Contract EY-76-C-06-1830. 14p. (CONF-780533—3). Dep. NTIS, PC A02/MF A01.

From Symposium on cooling tower environment; College Park, MD, USA (2 May 1978).

A comprehensive experimental study of drift emissions and downwind deposition from a mechanical draft cooling tower is planned for early spring 1978. The objective of the experiment is to develop a data base which can be used for validation of drift deposition models. The key aspects of the study are to measure the characteristics of the drift emitted from the tower, the ambient meteorological conditions responsible for the transport and dispersion of the drift, and the downwind deposition and near surface air concentration patterns of the drift. The source characteristics, including air temperature and velocity profiles at the tower exit, and the transport parameters are to be used as inputs to the models, while the deposition patterns are to serve as comparisons to the outputs of the models.

10534 (UCID—18504) **Chabot Observatory remote sensing experiments (CORSE)-progress 1978-79.** Porch, W.M.; Galloway, T.R.; Green, T.J.; Waidl, J.O.; Futshcer, P.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jan 1980. Contract W-7405-ENG-48. 30p. Dep. NTIS, PC A03/MF A01.

A cooperative effort yielded several important results and new techniques for remote sensing of atmospheric parameters. An electro-optical system was developed which simultaneously analyzes regional scale atmospheric constituents such as aerosols H_20, 0_2, NO_2, and 0_3 while measuring long path averaged wind and atmospheric turbulence in the San Francisco Bay Area. Future plans include improving these techniques to remotely determine vertical temperature profiles inversion heights, heat fluxes and vertical gradient wind speeds.

10535 Method for modeling the deposition of sulfur by precipitation over regional scales. Hicks, B.B.; Shannon, J.D. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, IL 60439). *J. Appl. Meteorol.;* **18**: No. 11, 1415-1420(Nov 1979).

Radioactive fallout data suggest that the concentration of pollutants in rainfall, while highly variable, might be described on the average by about an inverse half-power dependence on the amount of precipitation. Recent measurements of sulfur concentrations in summer rainfall collected at Argonne National Laboratory tend to support this contention, as do preliminary results derived from operations of the DOE precipitation chemistry network. The concept is extended to develop a bulk removal rate for airborne total sulfur by precipitation for use in regional dispersion modeling.

10536 Examination of regional pollutant structure in the lower troposphere—some results of the diagnostic atmospheric cross-section experiment (DACSE-I). Sisterson, D.L.; Shannon, J.D.; Hales, J.M. (Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory, Argonne, IL 60439). *J. Appl. Meteorol.;* **18**: No. 11, 1421-1428(Nov 1979).

The diurnal variation of the structure of pollutant transport and diffusion in the Ohio River Valley is examined by combining meteorological cross sections with vertical profiles of several air pollutants. An increased frequency of rawinsonde releases from NWS stations at Salem, Dayton and Pittsburgh during the period 1—10 August 1977 was supplemented on 5 and 6 August by vertical profiles taken along the cross-section line by an aircraft. The data on 5 August, a day without convective activity to complicate analyses, merit special study. Analyses of the b/sub scat/ structure superimposed on the meteorological cross sections lend support to the theory of horizontal transport of polluted layers above the nocturnal inversion or developing mixed layer without significant dilution. The effect of the daily breathing of the planetary boundary layer on the vertical structure of pollutants can be seen in the sequence of cross sections.

10537 Potential constants and dissociation pathways. Jones, L.H.; Ryan, R.R. (Los Alamos Scientific Lab., NM). *J. Mol. Struct.;* **46**: 35-42(1978).

There has been ambiguity in the literature concerning the concept of minimum energy pathways for unimolecular dissociation. The interaction displacement coordinates obtained from a vibrational analysis of the infrared and Raman spectra indicate a constrainted minimum energy pathway in the quadratic approximation. On the other hand, the unconstrained minimum energy path follows the minimum gradient on the potential energy surface which initially follows one of the normal coordinates. The difference in these concepts was investigated using the CO_2 molecule as a simple example. Though an accurate potential function is not known, a good quartic function has been obtained by Suzuki. Of course at CO bond displacements corresponding to O + CO it is known that the remaining CO bond length must be that of the CO molecule. The quartic function is not satisfactory much beyond 0.3 A displacement of either bond; however, a Morse function can be expected to give satisfactory behavior at large displacements. On the other hand, simple Morse functions for the two bonds do not allow for any coordinate interactions, so other terms must be included. The quartic function of near equilibrium was fit with a simple combination of two Morse functions plus a valence bond-bond interaction term which decreases at increased displacement of either bond. Bending motion is neglected for simplicity. Application to other linear triatomics, such as CS_2 and N_2O are discussed also. A few comments are presented on the CNF molecule, a somewhat more complicated species.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 10509, 10567, 10571, 10660, 10670

10538 (DP—1526) **Savannah River Laboratory environmental transport and effects research. Annual report, 1978.** Crawford, T.V. (comp.). (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Nov 1979. Contract EY-76-C-09-0001. 242p. Dep. NTIS, PC A11/MF A01.

Research in the environmental sciences by the Savannah River Laboratory during 1978 is described in 43 articles. These articles are in the fields of terrestrial ecology, geologic studies, aquatic transport, aquatic ecology, atmospheric transport, emergency response, computer methods development, ocean program, and fuel cycle program. Thirty-seven of the articles were abstracted individually for ERA/EDB; those in scope were also included in INIS.

10539 (DP—1526, pp 21-27) **Source term estimations of the ruthenium release on November 6, 1978.** Pendergast, M.M.; Weber, A.H. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

On November 6, 1978, an undetermined amound of ^{106}Ru was released in a 2-hour period to the atmosphere from F Area of the Savannah River Plant. The amount released could not be determined by measurement within the process or by monitoring within the stack. Using measurements of meteorology and ^{106}Ru in the environment and different atmospheric dispersion models, the amount released was determined to range between 24 and 52 Ci, with an average of about 32 Ci.

10540 (DP—1526, pp 29-32) **Model evaluation for travel distances of 30-140 km.** Pendergast, M.M. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Krypton-85 released as the result of routine operations at Savannah River Plant was used to evaluate how well two different models predict 10-h average concentrations at travel distances of 30 to 140 km. The segmented plume model is almost twice as accurate as the wind rose model in evaluating transport of a short-term (10-h) release, while it is only slightly more accurate over larger averaging times. Adding hourly varying stability only slightly improves the segmented plume model when assuming neutral stability for all times.

10541 (DP—1526, pp 73-77) **Extensions to the JEREMIAH atmospheric computational system.** Buckner, M.R.; Beranek, F.; Pendergast, M.M. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A modular environmental transport and dose system, known as JEREMIAH (Buckner, 1977), has been under development to provide a computational framework for transport model evaluation and parametric studies. The objective is to provide a fast-running, reliable system which will provide reasonable estimates of the dose resulting from a chronic or acute radioactive release. More sophisticated models are also being provided in the system to perform generic and scoping studies for use in tuning the simpler model. The overall structure of the JEREMIAH system is illustrated. New modules in the system include ATSTAB, which determines the atmospheric stability category, and AD2MOM, which solves the three-dimensional advective-diffusion equation.

10542 (DP—1526, pp 107-109) **Physical and chemical characteristics of plutonium-bearing particles released to the atmosphere from the Savannah River Nuclear Fuel Reprocessing Plant.** Sanders, S.M. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Particulate plutonium released to the atmosphere from the 291-F stack was found to be carried on aggregates composed mainly of crustal materials which have a geometric mean diameter of 5.4 μm. About 10^6 of these particles containing an average of less than 1 fCi of ^{239}Pu per particles are released to the atmosphere per minute. This gives an average concentration in the off-gas of about 5 plutonium-bearing particles/ft^3.

10543 (EML—367, pp 26-37) **Environmental radon and radon daughters at Chester.** George, A.C.; Breslin, A.J. Oct 1979.

In Environmental Measurements Laboratory regional baseline station, Chester, New Jersey.

Field testing of the Environmental Radon Monitor (ERM-2) was completed in 1978 and the monitor has been in routine operation since January 1979. It samples from a height of 10 meters on the meteorological tower. During field testing the contribution of thoron was found to be significant and a 900 liter chamber was installed upstream from the ERM-2 to provide adequate time for the thoron to decay. The monthly average radon concentration from January through August is tabulated. Concentrations during the period from January through April are substantially lower than those during May through August. This finding is reasonable because radon flux during the cold weather is reduced substantially.

10544 (EML—370) **Environmental Measurements Laboratory. Environmental quarterly, September 1 through December 1, 1979.** Hardy, E.P. Jr. (Department of Energy, New York (USA). Environmental Measurements Lab.). 1 Jan 1980. 117p. Dep. NTIS, PC A06/MF A01.

This report presents current information from the EML environmental programs, the Radiological and Environmental Research Division at Argonne National Laboratory and the New Zealand National Radiation Laboratory. The initial section consists of interpretive reports and notes dealing with the quality of radionuclide and trace metal analyses of air filter samples, the quality of strontium-90 and transuranic analyses of biological and soil samples, and the quality of atmospheric carbon dioxide measurements. Each of the last three sections was abstracted and indexed individually for ERA/EDB.

10545 (EML—370, pp I.3-I.29) **EML Surface Air Sampling Program: the quality of analysis, 1978.** Toonkel, L.E.; Feely, H.W. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly, September 1 through December 1, 1979.

The Surface Air Sampling Program systematically samples and analyzes the particulate matter in surface air for various radioactive components and for several trace metals. In general the quality of the analyses in the Surface Air Sampling Program in 1978 was satisfactory. The accuracy averaged within 15% and the mean precision was within +- 15% in almost all cases. Results of trace metal duplicate analyses performed by x-ray fluorescence on early 1977 samples are included. Although many metals are near the limit of detection, the precision of measurements was usually better than the measurement uncertainties. Also, there appears to be improvement in the detection limits compared to last year.

10546 (EML—370, pp II.4-II.24) **High Altitude Balloon Sampling Program.** Leifer, R.; Toonkel, L.E.; Larsen, R. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly, September 1 through December 1, 1979.

Balloon borne filtering devices are used to collect nuclear debris at altitudes from 20 to 27 km. Balloon launchings are conducted annually at Fairbanks, Alaska (64°N) and the Panama Canal Zone (9°N), and three times a year at Alamogordo, NM (33°N). Filters are anayzed for a number of radionuclides. A description of the program and available data are given.

10547 (EML—370(App.)) **Environmental Measurements Laboratory. Environmental quarterly.** Toonkel, L.E. (Department of Energy, New York (USA). Environmental Measurements Lab.). 1 Jan 1980. 374p. Dep. NTIS, PC A16/MF A01.

Each section of the report was abstracted and indexed for ERA/EDB. Sections include tabulations of quarterly ^{90}Sr fallout, chemical constituents of wet and dry deposition, radionuclide and trace metal concentrations in surface air, radionuclide concentrations in the upper atmoshpere and ^{90}Sr concentrations in milk and tap water. A bibliography of recent publications related to environmental studies is also presented.

10548 (EML—370(App.), pp A.1-A.41) **Quarterly ^{90}Sr deposition at world land sites. Appendix A.** Toonkel, L.E. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly.

The results of quarterly ^{90}Sr fallout sampling data at 77 sites beginning in 1976 are presented. Of the 77 sites for which quarterly data are reported, the monthly collections at 69 sites are composited and analyzed quarterly starting with the July 1976 samples. Data reported for the first half of 1976 at these sites as well as for the whole year at New York City and through June 1977 at the Australian sites, are quarterly results obtained by summing the monthly data. As of July 1977, the Australian sites have changed over to quarterly collection. The collections are made using either high-walled stainless steel pots with exposed areas of 0.076 square meters or plastic funnels with exposed areas of 0.072 square meters to which are attached ion-exchange columns. A few sites which were established as part of a precipitation chemistry network use plastic pots with an area of 0.064 square meters for collection.

10549 (EML—370(App.), pp C.1-C.191) **Radionuclides and trace metals in surface air. Appendix C.** Feely, H.W.; Toonkel, L.E.; Larsen, R.J. 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly.

The primary objective of this program is to study the spatial and temporal distribution of specific natural and man-made radioisotopes, and of trace metals in the surface air. Sampling stations and their locations around the world are listed, and results since 1963 are tabulated. Gamma spectra of the monthly composites are obtained using a lithium-drifted germanium diode (GeLi) system. Concentrations of the gamma emitting nuclides, Be-7, Zr-95, Cs-137, and Ce-144 are determined by computer resolution of the spectra. Over the course of the program numerous nuclides have been measured radiochemically for a variety of reasons. Special interest has centered on Sr-90 and the plutonium isostpes because of their potential relation to health effects as well as their usefulness as atmospheric tracers. Other nuclides, such as Mn-54, Fe-55, and Cd-109, have been utilized as tracers for specific series of nuclear detonations. The choice of isotopes analyzed during any given period of time reflects the current research objectives being pursued. The content of stable lead is determined using atomic absorption flame spectrometry. X-ray fluorescence is used for analyzing samples for titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, and lead. (JGB)

10550 (LA—8023-PR, pp 38-42) **Fine particle studies.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Filtration of small, high-density particles by HEPA filters has been studied in the laboratory to simulate performance against plutonium oxide aerosols of similar size and concentration and to define the size of maximum penetration (SMP). These studies show that, because of the enhanced collection of particles larger or smaller than the SMP, quality control tests are somewhat conservative in predicting performance under field conditions for high-density polydisperse aerosols. Development of a Prototype Particulate Stack Sampler for the Environmental Protection Agency was continued. The sampler is approaching the final design status and a schematic is included. Aerosol production, characterization, and administration in the LASL inhalation toxicology programs were studied. Aerosol materials include ^{239}Pu oxide generated from an aqueous suspension, plutonium-uranium oxide mixture generated from a solution, and raw and spent oil shale aerosols dispersed with a Wright dust feed. One of the unknowns in the calculation of long-range transport of airborne particulate comtaminants from energy production facilities is the resuspension source term. Some measurements have been made of contaminant and soil resuspension by wind and mechanical forces, but the variability of these and lack of understanding of the mechanics involved have prevented their incorporation into transport models. One method for investigating fundamentals of the resuspension process is by simulation in a wind tunnel. This technique was described.

10551 (NUREG/CR—1216) **Radioisotopic composition of yellowcake: an estimation of stack release rates.** Momeni, M.H.; Kisieleski, W.E.; Rayno, D.R.; Sabau, C.S. (Argonne National Lab., IL (USA)). Dec 1979. Contract W-31-109-ENG-38. 31p. (ANL/ES—84). Dep. NTIS, PC A03/MF A01.

Uranium concentrate (yellowcake) composites from four mills (Anaconda, Kerr-McGee, Highland, and Uravan) were analyzed for U-238, U-235, U-234, Th-230, Ra-226, and Pb-210. The ratio of specific activities of U-238 to U-234 in the composites suggested that secular radioactive equilibrium exists in the ore. The average activity ratios in the yellowcake were determined to be 2.7×10^{-3} (Th-230/U-238), 5×10^{-4} (Ra-226/U-238) and 2×10^{-4} (Pb-210/U-238). Based on earlier EPA measurements of the release rates from the stacks, the amount of yellowcake released was determined to be 0.1% of the amount processed.

10552 Analysis of NRC methods for estimating the effects of dry deposition in environmental radiological assessments. Miller, C.W.; Hoffman, F.O. (Oak Ridge National Lab., TN). *Nucl. Saf.*; 20: No. 4, 458-467(Jul 1979).

The methods contained in Meteorology and Atomic Energy - 1968, which are commonly used for estimating the effects of dry deposition in radiological assessments, have been compared to the methods contained in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.111. Although designed for use when determining compliance with Title 10, Code of Federal Regulations, Part 50, Appendix I for light-water-cooled reactors, the NRC guide has the potential of being used for other types of nuclear reactors and for nuclear facilities as well. This comparison has raised a number of concerns about the NRC approach: (1) deposition rate estimates are independent of the user's calculated air concentration; (2) deposition estimates for elevated releases seem too high close to the source; and (3) the plume depletion curves in the guide do not behave as expected relative to the commonly used plume depletion method. In view of these concerns, it is recommended that other, simpler approaches to these processes be considered for radiological assessment purposes.

10553 (COO—2736-2) **Some aspects of organic and inorganic particulate transport at Rocky Flats. Final report.** Nichols, H. (Colorado Univ., Boulder (USA). Inst. of Arctic and Alpine Research). [nd]. Contract EY-76-S-02-2736. 25p. Dep. NTIS, PC A02/MF A01.

Findings from the summer 1975 sampling program and the conclusions from the 1975-1976 winter sampling program are summarized. Large radionuclide particles were not found attached to pollen. Sampling the airborne pollen throughout the Rocky Flats area demonstrated that the Rocky Flats air samplers were deficient in their abilities to properly collect large lightweight pollen grains. This may not have serious consequences for the undetected transport of radionuclides by pollen, however, it has implications of sampling inefficiency in some particulate size ranges, and implies that if radionuclides are carried at times by larger particles, then the standard Rocky Flats air samplers are not sampling these materials efficiently. Some initial findings suggested that soil samples from downwind areas associated with winter snow accumulation had abnormally high fissile particle accumulations, and this suggested the need to sample these sites in winter. Areas of preferred particle accumulation such as snow banks had higher concentrations of radionuclide particles than surrounding areas which are more windswept. Any soil sampling program at Rocky Flats which seeks to monitor background radionuclide levels and movement of fissile particles across the site should take account of these topographically and wind-controlled accumulation areas, and not rely solely on a grid pattern of sampling. The snow samples contained radionuclide material in substantial quantities. In terms of fissile particulates smaller than 0.5 microns the snow banks three miles east of the plant site contained as much or more radionuclides than sites close to the Hot Spot contaminated area. The snow samples immediately east of the Hot Spot contained many more large particles (>0.5 m), as did soil samples from the upwind site next to the plant fence. The Hot Spot is clearly implicated again as the source of these materials.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 10525

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 10579, 10583

REGULATIONS

10554 (ORNL/TM—6784) **Statutory requirements for ambient and ecological effects monitoring at DOE energy activity sites.** Sanders, F.S.; Reed, R.M.; Huber, E.E.; Tucker, C.S. (Oak Ridge National Lab., TN (USA)). Nov 1979. Contract W-7405-ENG-26. 108p. Dep. NTIS, PC A06/MF A01.

Major federal environmental protection legislation, regulations, and regulatory implementation procedures were reviewed and summarized with respect to site-specific ambient and ecological effects monitoring requirements at DOE energy activity sites. Three states (California, Wyoming, and Maryland) were also considered with respect to their implementation of federal regulations (as permitting states) plus any state requirements for environmental monitoring that are in addition to federal needs. It was found that, except for the National Environmental Policy Act (NEPA), little ecological effects monitoring is actually required under federal statutes. For instance, some pre-application effects monitoring (before a discharge permit is issued) is required for atmospheric and aqueous waste discharge, under the Clean Air Act of 1977 and the Clean Water Act of 1977, respectively, but no follow-up monitoring is usually required as would provide for site-specific ecological impact assessment of permitted activities. Some extensive pre-application ambient monitoring may be required under non-NEPA federal statutes but little follow-up (compliance) monitoring is evident. Concern for environmental quality at the state level is more closely attuned to local environmental degradation, but states lack monitoring resources and, in general, add no additional requirements to federal regulatory needs. NEPA provides the only realistic guidelines for ecological effects assessment under current interpretation of federal and state environmental protection legislation. This act will undoubtedly continue to be the main guide to the investigation of ecological changes from ongoing and proposed federal activities, including the promotion of new energy technologies by DOE.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

REFER ALSO TO CITATION(S) 10654

BASIC STUDIES

10555 (DP—1526, pp 183-186) **Measurement of thermal conductivity and heat flux in soil.** Murphy, C.E. Jr.; Kaplan, S. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Energy balance techniques are being employed to determine the heat and mass transfer characteristics of a typical pine forest in the Savannah River Plant area. One term of the energy balance of the forest is the heat transfer to the ground under the canopy. Knowledge of the heat transfer characteristics of the soil allows determination of the magnitude of the soil heat transfer. Measurement indicated the thermal conductivity is 0.00882 cal/cm-sec-°C and the thermal diffusivity is 0.0145 cm^2/sec.

10556 (DP—1526, pp 197-199) **Water movement in a pine forest.** Dexter, A.H.; Murphy, C.E. Jr. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The cycling of pollutants within a pine forest must take into account the soil water movement because most pollutants move through soils in the aqueous phase. The results for a slash pine forest on the Savannah River Plant site indicate that evapo-transpiration and drainage each account for approximately 60 cm/year of water movement out of the soil profile.

10557 (DP—1526, pp 203-205) **Properties of geologic membranes affecting the magnitude of osmotic pressure.** Fritz, S.J. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

It has been demonstrated that geologic material can act as an osmotic membrane when clays separate fluids of different salinity. The effect of the fluid characteristics on this phenomena are well known (Fritz, 1978), but geologic materials have not been well studied. Four clays are used in this study to show that osmotic efficiency is controlled by clay mineralogy and its porosity, as well as solution properties.

10558 (DP—1526, pp 207-212) **Subsurface hydrology of coastal plain sediments in the SRP separations areas.** Root, R.W. Jr. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

An understanding of the three-dimensional flow of ground water beneath the Savannah River Plant separations areas requires a complete knowledge of hydraulic head in the area. As would be expected, the water table map shows the greatest relief of the three hydraulic head maps and also shows the highest gradient, as it is influenced by many small tributaries. Both the water table and the potentiometric surface of the McBean Formation show large depressions caused by their drainage to both Upper Three Runs Creek and Four Mile Creek. On the other hand, the potentiometric surface of the Congaree Formation, which is not intersected by the valley of Four Mile Creek, shows only a depression caused by Upper Three Runs Creek. The gradient in the Congaree is also low compared to the gradient of the water table and the McBean Formation.

10559 (DP—1526, pp 213-217) **Results of drilling a well cluster near F area at SRP.** Root, R.W. Jr. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A cluster of five wells was drilled on the bluff above Upper Three Runs Creek in the northwestern part of the Savannah River Plant separations areas to confirm the conceptual geohydrologic model in this area. This well cluster confirmed the existence of the tan and green clays at this site, the downward gradient of hydraulic heads in the Barnwell and McBean formations, and the upward gradient of hydraulic heads in the Congaree and Ellenton formations. The upward head gradient in the Congaree and Ellenton formations suggests that water is discharging into Upper Three Runs Creek from these formations. This information is useful in developing a three-dimensional model of ground water movement and potential contaminant transport.

10560 (DP—1526, pp 219-222) **Well data computer file.** Krapp, C.W.; Suich, J.E. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A computer file is currently being developed to provide a centralized access to pertinent data for Savannah River Plant (SRP) wells. Obtaining this data requires searching the files of six departments onsite and in Wilmington, Delaware. The computer file will include data on industrial, domestic, construction, monitoring, and exploratory wells drilled on SRP.

10561 **Annual energy budgets for three common rodent species in the northern Great Basin.** Schreiber, R.K. (Univ. of Idaho, Moscow). Contract AT(45-1)-2042. *Great Basin Nat.;* **39**: No. 2, 143-154(30 Jun 1979).

Annual energy budgets were calculated for three species of small mammals (Peromyscys maniculatus, Onychomys leucogaster, Reithrodontomys megalotis) from the northern Great Basin, Benton County, Washington. Individual ingestion rates were based on species activity, microclimate regime, coefficient of digestibility, caloric diet, and the cost for reproduction. For males and females, the estimated energy expenditures were: P. maniculatus, 6080, 5891; O. leucogaster, 5714, 6587; and R. megalotis, 4057, 3791 kcal/y. By comparison, each species on an individual basis processes more energy annually than the more abundant species in the community, Perognathus parvus, but their total contribution to community energy flow is apparently minor. Integration of these results with other ecological parameters is necessary to develop new hypotheses on the role of small mammal consumers in cold desert ecosystems.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 10519

10562 (LA—8023-PR, pp 145-173) **Environmental science group (H-12).** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Several ongoing research programs in environmental aspects of fossil, solar, geothermal, and nuclear areas are summarized. The topics discussed are: the behavior of glycols in soils; the effects of ethylene and propylene glycol on seedling germination; nitrogen limits to plant growth; radon flux and trace element studies at inactive uranium mill tailing piles; the ecological investigation of dry geothermal energy at Fenton Hill; an environmental assessment of the dry deposition of trace elements onto surrounding terrain as a result of stack emissions from a coal-fired power plant; the comparative distribution of stable mercury, cesium 137, and plutonium in an intermittant stream at Los Alamos; trace element mobilization by a particulate scrubber/coal ash disposal system; and the mule deer movements and a botanical survey of Los Alamos National Environmental Park.

10563 (PB—292947) **Environmental management and energy facility siting in the coastal zone. Final report.** (Seton, Johnson, and Odell, Inc., Portland, OR (USA); Cogan and Associates, Portland, OR (USA)). 25 Aug 1978. Contract EPA-68-01-3955. 161p. NTIS PC A08/MF A01.

This report studied the issue of integrating air and water quality planning, coastal zone management, and energy facility siting activities in coastal areas of California, Oregon, and Washington. The study considered exploration, extraction, refining, storage, transfer, and shipment of oil and gas; thermal power plants; and construction and fabrication yards for oil drilling equipment to be used on the outer continental shelf. After identifying problems in the regulatory process, recommendations were developed to deal with these problems and included suggestions to consolidate the state and federal environmental review procedures, reduce duplication in permit applications, and clarify interagency relationships.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 10538, 10544, 10553, 10670

10564 (DP—1526, pp 57-63) **Data base for terrestrial food pathways dose commitment calculations.** Bailey, C.E. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A computer program is under development to allow calculation of the dose-to-man in Georgia and South Carolina from ingestion of radionuclides in terrestrial foods resulting from deposition of airborne radionuclides. This program is based on models described in Regulatory Guide 1.109 (USNRC, 1977). The data base describes the movement of radionuclides through the terrestrial food chain, growth and consumption factors for a variety of radionuclides.

10565 (DP—1526, pp 179-181) **Tritium cycling in a tree spiked with tritiated water.** Murphy, C.E. Jr.; Luvall, J.C. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Transfer and turnover rates in forests are important to compute the residence time of tritiated water in an area following an accidental release. In this study tritium was injected in the base of 7 year old, loblolly pine (Pinus taeda, L) trees to determine the rate of transfer through the trees and the turnover in the trees independent of the soil. The results indicate the flow rates depend on the rate of water movement through the tree, which is influenced by the microclimate, and exchange of tritium with hydrogen exchange sites in the tree. The initial pulse of tritium appears to move through the tree in about four days. The descending portion of the curve can be described as a two compartment model with half-lives of 1.41 and 21.7 days. There is some evidence that a longer turnover compartment is associated with metabolically fixed tritium.

10566 (DP—1526, pp 191-196) **Model of tritium cycling in the vicinity of SRP.** Murphy, C.E. Jr.; Pendergast, M.M. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Patterns of tritium dispersion in the environment surrounding Savannah River Plant (SRP) indicate a power-law relationship between air concentration and distance from the source. The relationship between the concentration of tritiated water in vegetation and distance is more complex. A model of the tritium dispersion and cycling in the environment explains the dispersion patterns in terms of the ratio of tritiated hydrogen to tritiated water, climate, and vegetation characteristics. The annual variation in the environmental patterns around the SRP is almost completely determined by the source strength and the fraction of tritiated hydrogen (HT) in the release as mediated by the conversion of tritiated hydrogen to tritiated water (HTO) in the vegetation and soil.

10567 (EML—363, pp I.87-I.108) **Worldwide deposition of ^{90}Sr through 1978.** Feely, H.W.; Toonkel, L.E. 1 Oct 1979.

In Environmental Measurements Laboratory environmental quarterly, June 1-September 1, 1979.

The total deposition of ^{90}Sr on the surface of the earth during 1978 was 118 kilocuries. The worldwide cumulative deposit decreased to about 11.0 megacuries as the decay of previously deposited ^{90}Sr slightly exceeded the amount of the new deposit. The November 1976 Chinese atmospheric nuclear test probably contributed 84% of the ^{90}Sr deposited during 1978. It is estimated that this nuclear test injected 207 kilocuries of ^{90}Sr into the stratosphere.

SOIL

REFER ALSO TO CITATION(S) 9727, 9728, 10551, 10591, 10592, 10671

10568 (DP—1526, pp 99-103) **Distribution of iodine-129 released from SRP in soil as a function of distance.** Anderson, T.J. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The impact of Savannah River Plant (SRP) airborne ^{129}I emissions in distinguishable from background at distances of 160 km from the source with a high sensitivity neutron activation analysis. An existing probability distribution model based on 2 years of meteorological data provides a reasonable estimate of ^{129}I deposition as a function of direction and distance. The vertical distribution of ^{129}I in the sandy clay soils indicates slow vertical transport, implying a long residence time in regions of the soil which are subject to agricultural activity.

10569 (DP—1526, pp 105-106) **Methodology for the determination of environmental technetium-99.** Anderson, T.J. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A mass spectrometric isotope dilution technique was developed with ^{97}Tc as a yield tracer to measure as little as 0.1 pg of environmental ^{99}Tc. A unique aspect of the method is loading the sample into the mass spectrometer in the form of a single ion-exchange resin bead, thereby improving the signal-to-noise ratio over conventional solution loading. Application of a modified method detected ^{99}Tc in samples from around Savannah River Plant's seepage basins and confirmed its high mobility in the local water-saturated soil.

10570 (DP—1526, pp 111-112) **Development of a borehole probe detector for measurement of radionuclide transport in ground water.** Bowman, W.W. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Auxiliary equipment and procedures were developed for operation of a borehole probe to measure gamma activities in soil surrounding ground water monitoring wells at a detection limit of about 0.02 pCi/g. By measuring these activities as a function of depth in burial ground monitoring wells, the rate and extent of migration of activities from the burial trenches toward the water table can be quantified.

10571 (DP—1526, pp 173-174) **Effect of disking and other agricultural practices on the distribution of surface deposited plutonium in soil.** Corey, J.C.; Pinder, J.E.; Adriano, D.C. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Two old fields near a chemical separations facility were recently farmed to determine the behavior of Pu deposited on the soil surface due to routine low-level stack releases during the last 20 years. The soil was disked thoroughly in preparation for a wheat crop in 1974 and a soybean crop in 1975. The agricultural practices did not materially increase the plutonium concentration in the 15 to 30 cm depth nor reduce the plutonium in the surface 0 to 5 cm depth. There was a considerable increase in the 5 to 15 cm depth.

10572 (EML—362) **Natural radiation background of Utah: preliminary report on radionuclides in soils in populated areas.** Beck, H.L. (Department of Energy, New York (USA). Environmental Measurements Lab.). Aug 1979. 21p. Dep. NTIS, PC A02/MF A01.

External radiation exposure rates were measured at over 150 sites in 56 cities and towns in Utah using in situ field gamma-ray spectrometric and high pressure ionization chamber systems. These measurements are part of a more extensive radiological survey of Utah by this Laboratory to determine residual levels of fission products and transuranic nuclides in soils as a result of nuclear weapons tests at the Nevada Test Site (NTS) during 1950-58. Open field exposure rates from natural terrestrial gamma-ray sources are fairly uniform around the state and are comparable to the mean exposure rate for the US. However, exposure from cosmic-ray secondaries in Utah is about 50% higher than for most other US residents, due to the higher altitude. No significant difference was found in the population-weighted mean annual exposure from terrestrial gamma radiation to persons living in the part of the state that is closest to the NTS relative to those living in more distant counties, although the former receive, on average, a slightly greater cosmic-ray exposure.

10573 (LA—8147-MS) **Determination of hydraulic conductivity in crushed Bandelier Tuff.** Abeele, W.V. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

The unsaturated hydraulic conductivity in a sample of crushed Bandelier Tuff was evaluated using volumetric pressure plate extractors. The total impedance of the tuff sample is determined from the experimental outflow data for each pressure step applied. The determination of the membrane impedance is not compulsory and the varying contact impedances are taken into account at each different pressure step. The results show that predictions of saturation ratios can be made based on knowledge of matric potentials just as predictions of hydraulic conductivities can be made based on knowledge of either matric potentials or saturation ratios. They are highly significant at the equivalent of a matric potential lower than -10 kPa. These results are then compared to those obtained by means of the predictive methods promoted by Campbell and Millington-Quirk using moisture retention data.

10574 (NUREG/CP—0001, pp 369-375) **Radium-226 content of agricultural gypsums.** Lindeken, C.L.; Coles, D.G. (Univ. of California, Livermore). Aug 1978.

In Radioactivity in consumer products.

Gypsum is widely used as an amendment to improve water movement in saline-alkali soils, and may also be substituted for limestone or lime to supply calcium to soils that are alkaline. Most agricultural gypsum is obtained by quarrying the mineral, but substantial quantities are also produced as a byproduct in various chemical processes. At present, the principal source of byproduct gypsum is the phosphate fertilizer industry, and in the United States, Florida is the major source of phosphate rock. In a previous study, it was found that soils heavily treated with phosphate fertilizers contained elevated levels of ^{238}U over those expected from ^{226}Ra measurements. In the soil, the relative immobility of uranium with respect to plant uptake is well recognized. However, since the properties of radium in the uranium decay chain are similar to those of calcium, the radium content of phosphogypsum is of greater health physics interest. This paper compares the ^{226}Ra and the ^{238}U content of quarried gypsums and phosphogypsums. Samples of quarried gypsum were obtained from Nova Scotia, Iowa, Texas, and California. Phosphogypsum samples were derived from Florida land pebble phosphates. (RJC)

10575 (PNL-SA—7257) **Environmental processes leading to the presence of organically bound plutonium in plant tissues consumed by animals.** Wildung, R.E.; Garland, T.R.; Cataldo, D.A. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jan 1979. Contract EY-76-C-06-1830. 18p. (CONF-790325—10). Dep. NTIS, PC A02/MF A01.

From International symposium on biological implications of radionuclides released from nuclear industries; Vienna, Austria (26 Mar 1979).

The long half-life of plutonium (Pu) and its possible entry into the environment as a result of the nuclear fuel cycle necessitate estimation of its availability to animals over thousands of years. A major uncertainty in this evaluation arises from the effects of physical and biogeochemical processes on Pu form and biological availability. However, a general understanding of the principal mechanisms governing Pu behavior in the terrestrial ingestion pathway is developing which ultimately should serve as a framework for estimation of long-term availability to animals. This review briefly integrates and synthesizes present information on the chemical/biochemical processes governing the form of Pu in soils and plants and the relationships of these phenomena to gut absorption in animals. A proposed model for Pu behavior will be used as a framework for integration of current knowledge.

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 9729, 10547, 10575

10576 (EML—370, pp III.3-III.6) **Cesium-137 in various Chicago foods (collection month, October 1979).** Karttunen, J.O. (Argonne National Lab., IL). 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly, September 1 through December 1, 1979.

Since April 1961, the ^{137}Cs and potassium content of the Chicago portion of the Tri-City Diet Sampling Program has been determined in bulk food samples by gamma-ray spectrometry using a 4" x 4" NaI(Tl) crystal. Each variety of food (all fresh vegetables, all fresh fruit, etc.) is composited before measurement, and each sample is counted 400 to 1000 minutes. From these measurements

composite daily and yearly food intakes are obtained. The results for the October 1979 semi-annual sampling are tabulated.

10577 (EML—370(App.), pp D.1-D.7) **Radiostrontium in milk and tap water. Appendix D.** 1 Jan 1980.

In Environmental Measurements Laboratory. Environmental quarterly.

Results of monitoring milk and tap water in New York City are presented. The New York City sample is a monthly composite of pasteurized milk purchased daily at retail stores. The monthly ^{90}Sr to calcium ratios for New York City since the inception of the sampling program in 1954 are presented. Samples of New York City tap water are taken daily, so that by the end of the month, approximately 100 liters have been collected. The available cesium-137 data expressed as the ^{137}Cs to ^{90}Sr ratio are also given. (JGB)

10578 (PB—293657) **Preliminary analysis of first crop of plants grown in seven soils uniformly contaminated with four transuranic elements simultaneously. Quarterly progress report.** Wallace, A.; Romney, E.M.; Nishita, H.; Schultz, E.K. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Mar 1979. Contract NRC-60-76-103. 17p. NTIS PC A02/MF A01.

A forage crop and a grain crop of wheat were harvested from a replicated experiment with about 200 kg soil per container in which seven soils from different locations throughout the U.S.A. were spiked with four different transuranic elements simultaneously. Concentration Ratios (C.R.) for the radioactive elements in plants were obtained as a start to careful examination of parameters involved in the use of these ratios in models. The relative availability of the different radionuclides differed considerably with soil. One order of magnitude differences were common for element pairs. In general the order of plant availability was Np > Am > Cm > Pu. The differences that were encountered for soil for radionuclides present in straw were much less pronounced in the grain. The ratio of maximum(usually for the acid sandy soil) to minimum (usually for the soil with high soil organic matter) for straw varied from 1.9 to 2.5 orders of magnitude, but was one order or less for grain. This means that a small and more constant amount of transuranium element is transferred to grain relative to that in straw. The behavior is somewhat analogous to that of calcium. The results are to be very useful in refining of models.

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 10560

10579 (DOE/SR/10018—2) **Monitoring plan for long-term environmental measurements at the proposed Douglas Point Ecological Laboratory, Nanjemoy, Maryland.** Jensen, B.L.; Miles, K.J.; Strass, P.K.; McDonald, B.S.; Nugent, A. (Charles County Community Coll.. La Plata, MD (USA). Div. of Biological Sciences; Dames and Moore, Washington, DC (USA). Meteorological Div.). 25 Sep 1979. Contract AS09-79SR10018. 181p. Dep. NTIS, PC A09/MF A01.

The Douglas Point Ecological Laboratory has been set up at the site of a proposed power plant, which is to be powered by either nuclear, coal, or an alternate form of fuel. A plan for long-range monitoring of terrestrial ecosystems and atmospheric chemistry is presented. A site characterization study will be made initially. Chemical and physical soil profiles will be established with continuous measurement of soil moisture and nutrient content, as well as other parameters. Data sets will be established, reflecting changes in rainfall pH and rate of deposition through precipitation and dryfall sedimentation of Ca^{2+}, Mg^{2+}, K^+, Na^+, SO_4^{2-}, Cl^-, NH_4^+, and NO_3^-. Among other objectives are the development of new monitoring techniques that can be used to trace energy flow, nutrient transport, and radionuclide transport through all trophic levels to selected carnivores. The atmospheric monitoring plan is outlined as to system design and specifications; system installation, operation, and maintenance, data processing and reports; quality assurance program; and project organization. A discussion of administrative and operational monitoring costs is included. (JGB)

10580 (DP—1526, pp 223-225) **Earthquake damage to underground facilities.** Stephenson, D.E.; Pratt, H.R. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The damage to underground facilities caused by earthquakes was evaluated in order to determine potential seismic risk to an underground nuclear waste repository. Earthquake effects were delineated in terms of both displacements and accelerations. For underground facilities, displacements are considered more damaging than accelerations. An evaluation of the data was made in terms of acceleration, velocity, and displacement as a function of earthquake magnitude, distance, and depth. Damage decreases with distance from the source and with depth below the ground surface. However, extensive damage can occur if the facility is cut by a fault or fault fissure along which a slip can occur during an earthquake. Peak acceleration decreases with depth; however, peak displacements show much less reduction with depth.

10581 (DP—1526, pp 227-235) **Comparison of earthquake parameters derived from empirical relationships.** Stephenson, D.E. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A review was made of southeastern seismicity to illustrate the effects of attenuation, recurrence, and intensity-acceleration relationships on seismic design. For the attenuation relationships studied, intensity varies by a factor of about 2 for the eastern US depending on the data base and the methods of analysis. The largest variation is in the intensity-acceleration relationship, where for a given intensity at a site the acceleration may vary by a factor of about 4. All of these factors will affect the probabilities of occurrence of a specific intensity-acceleration calculated for a site.

10582 (FEA/G—77/102) **Use of brackish ground water resources for regional energy center development, Tularosa Basin, New Mexico: preliminary evaluation. Executive summary.** (Los Alamos Scientific Lab., NM (USA)). Mar 1977. Contract W-7405-ENG-36. 38p. Dep. NTIS, PC A03/MF A01.

Portions of document are illegible.

The objective of this study was to develop an impact and suitability profile for the use of the Tularosa Basin in south-central New Mexico as the potential location of an energy center. Underlying the Tularosa Basin is an aquifer system containing perhaps 40 million acre-feet of fresh and slightly saline (1-3 g/l) water that is theoretically recoverable and could be used for cooling and other energy-related or industrial purposes, particularly if energy development projects in other areas of the state and region are delayed, impeded, or cancelled because of uncertain availability or accessibility of water. This preliminary investigation of the Tularosa Basin reveals no outstanding features that would discourage further detailed analysis and planning for an energy complex. A major program of exploratory drilling, well logging, and testing is needed to determine aquifer characteristics and factors affecting well design. Since industrial development in the basin will necessarily involve Federal, state, and private lands, any serious plan will require collaboration of Federal, state, and local authorities.

10583 (ONWI—16) **Environmental characterization of bedded salt formations and overlying areas of the Salina Basin.** (Battelle Memorial Inst., Columbus, OH (USA). Office of Nuclear Waste Isolation). Sep 1979. Contract EY-76-C-06-1830. 379p. Dep. NTIS, PC A17/MF A01.

The suitability of the Salina Basin bedded salt region as a repository for underground disposal of radioactive wastes was reported. General information on the need for a repository, the technology development, the assessment process, a preliminary conceptual facility design, and anticipated impacts were included. The geology of the area including: stratigraphy, seismology, energy resources, and mineral resources was studied. The hydrology of the area was also studied as well as the climate. Socioeconomic studies of the area were also performed. Terrestrial and aquatic ecosystems were surveyed. (DMC)

REGULATIONS

REFER ALSO TO CITATION(S) 10554

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 9652

10584 **Bioenergetics of lotic filter-feeding insects Simulium spp. (Diptera) and Hydropsyche occidentalis (Trichoptera) and their function in controlling organic transport in streams.** McCullough, D.A. (Idaho State Univ., Pocatello); Minshall, G.W.; Cushing, C.E. Contract EY-76-C-06-1830; AT(45-1)-2042. *Ecology;* **60**: No. 3, 585-596(Jun 1979).

This study derives a set of bioenergetic parameters for the blackfly Simulium spp. (Diptera: Simuliidae) and the caddisfly Hydropsyche occidentalis (Trichoptera: Hydropsychidae) and evaluates the impact of these filter feeders on the lotic environment. In addition, comparison is made between field- and laboratory-derived estimates of ingestion and between 2 methods of calculating assimilation rate. Digestion (gut-clearance) time for Simulium ranged be-

tween 0.33 and 1.25 h compared to 1.54 to 2.63 h for Hydropsyche. Mean ingestion rate for Simulium in a series of experiments ranged from 1.36 to 54.74 μg DW/mg DW/h. The mean assimilation efficiency for diatoms was about 55% as measured by the dual-label technique. Mean ingestion rates of diatoms for Hydropsyche in 3 experiments were 31.3, 31.0 and 29.2 μg DW/mg DW/h, respectively; low values (3 μg DW/mg DW/h) from a 4th experiment were associated with high concentrations of green algae. An assimilation rate for diatoms of 7.5 μg AFDW/mg DW/h was derived for Hydropsyche. Measurements of growth rates of Hydropsyche under natural conditions were 3.6 to 4.4 μg DW/mg DW/h. Respiration rate of Hydropsyche for water ≧ 62% O_2 saturation was about 2.3 μl O_2/mg DW/h at 20°C. The results of this research in combination with literature derived values, yielded the following mean energy budgets for Simulium and Hydropsyche, respectively(J/mg/h): ingestion (C) 0.318, 0.393; respiration (R) 0.092, 0.042; growth (G) 0.092, 0.100; assimilation (A) (as C x AE) 0.182, 0.192; (as G + R) 0.184, 0.142 (values times 0.239 = cal/mg/h). The role of these filter feeders is discussed in terms of their processing of suspended organic material and in directing energy to higher trophic levels. Simulium and Hydropsyche (with net growth efficiences of 49.5 and 69.6%, respectively) are shown to be comparable to bacteria in terms of metabolic removal of organic C from food sources.

10585 Analysis of five North American lake ecosystems. VI. Consumer community structure and production. Wissmar, R.C. (Univ. of Washington, Seattle); Wetzel, R.G. *Int. Ver. Theor. Angew. Limnol.;* **20**: 587-597(Sep 1978).

Organic carbon budgets have been constructed for five lakes of varying trophic states: Findley Lake, Washington; Marion Lake, British Columbia; Lawrence Lake, Michigan; Lake Wingra, Wisconsin; and Mirror Lake, New Hampshire. Data sources pertaining to carbon budgets are given in other publications. These analyses have been useful in assessing the influence of autochthonous and allochthonous inputs upon different carbon pathways within lakes. This paper extends these analyses by examining the potential influence of these primary carbon sources upon respective consumer community structures and production.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 9651, 9654, 9655, 10016, 10519, 10525, 10563, 10679

10586 (DP—1526, pp 117-121) **Hydrogen sulfide concentration in Beaver Dam Creek.** Kiser, D.L. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Concentration-time profiles calculated with LODIPS for various hypothetical releases of hydrogen sulfide from the heavy water extraction facility predict lethal conditions for swamp fish from releases as small as 568 kg discharged over a period of 30 minutes or from releases of 1818 kg discharged over a period of 6 hours or less. The necessary volatilization and oxidation coefficients for LODIPS were derived from field measurements following planned releases of H_2S. Upsets in the operation of the wastewater strippers in the Girdler-Sulfide (GS) heavy water extraction facility in D Area have released significant amounts of dissolved H_2S to Beaver Dam Creek. Because H_2S is toxic to fish in concentrations as low as 1 mg/liter, the downstream environmental impact of H_2S releases from D Area was evaluated.

10587 (DP—1526, pp 123-128) **Stable cesium transport in an aquatic system.** Kiser, D.L. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

A field experiment in Four Mile Creek at the Savannah River Plant site was conducted to determine how cesium transport differed from conservative transport. Measurements following the release of stable cesium chloride to Four Mile Creek showed that most of the cesium released was transported downstream; however, the sorption-desorption behavior decreased the maximum concentration and increased the travel time and duration in comparison to a conservative dye tracer at sampling stations downstream.

10588 (DP—1526, pp 175-177) **Leachate concentrations of heavy metals from coal ash following sewage effluent application.** Horton, J.H.; Fawcett, T.R.; Corey, J.C. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Secondarily treated sewage effluent is currently being applied to an ash-filled basin on Savannah River Plant. The purpose of this study was to determine the leachate concentrations of As, Cd, Co, Cu, Hg, Pb, and Zr for ash columns to which distilled water or sewage effluent was applied. Sewage effluent application did not increase the concentration of the heavy metals in the effluent over those observed with distilled water.

10589 (PB—292706) **Investigation of the removal of trace toxic heavy metal ions from waste water by foam fractionation. Final report.** Okamoto, Y.; Chou, E.J. (Polytechnic Inst. of Brooklyn, NY (USA). Dept. of Chemistry). Apr 1978. Contract DI-14-30-3299. 65p. NTIS PC A04/MF A01.

The experimental work on the removal of a trace amount of metallic ions such as beryllium, cadmium, lead, mercury, copper and nickel from aqueous solution by a foam separation technique using chelating surfactants was investigated. Surfactants containing polyamine such as 4-dodecyldiethylene triamine were used as selective chelate surfactants. These ions could be removed quantitatively using a selected surfactant. These surfactants chelated with metallic ions which were found to be concentrated in the foam. The foam was removed from the liquid, and the surfactant was regenerated and recycled by the decomposition of the surfactant-metal ion complexes with Na2S and H2S. Those metal ions were precipitated as the metal sulfides and the regenerated surfactant was recycled. To establish the feasibility of using foam separation for the separation of a particular ion from one or more ions having similar charge, a selectivity coefficient was determined. The selectivity coefficient was found to be a function of surface tension of complexes and chelation constant of chelating surfactant with metallic ion.

10590 Chironomid influence on phosphorus release in sediment-water microcosms. Gallepp, G.W. (Univ. of Wisconsin, Madison). *Ecology;* **60**: No. 3, 547-556(Jun 1979).

Microcosms of Lake Mendota, Wisconsin, USA sediment and oxygenated water, maintained in darkness, were used to evaluate phosphorus increments in the overlying water as influenced by 2 species of chironomids, chironomid density and chironomid-temperature interactions. Similar systems were held in light and tested with algae present to determine if the presence of chironomids enhances algal growth. Both species, Chironomous riparius and Chironomus tentans, cause increases in phosphorus content of overlying water, with the larger C. tentans producing the greater effect. Release of total phosphorus at 20°C increased approximately linearly from 0.3 to 9.4 mg m^{-2} d^{-1} over a range of 6 densities from 0 to 6585 larvae/m^2. Increasing temperature from 10 to 20°C had little effect on phosphorus release rates in microcosms without chironomids, but in systems with C. tentans increased temperature resulted in a ≈ 10-fold increase in total phosphorus release rates. Most phosphorus released to the overlying water was soluble reactive phosphorus (SRP) which was quickly taken up by algae in lighted microcosms. Lighted controls had little total phosphorus in the overlying water or on glass substrates (wall growth), while microcosms with C. tentans contained significantly more total phosphorus in the overlying water and on glass substrates. Excretion by chironomids, rather than translocationof phosphorus from the interstitial waters of the sediment, could explain the observed data. Regardless of the mechanism, chironomids enhance phosphorus release and where abundant in the aerobic regions of lake sediments, their activities may be expected to result in a significant source of phosphorus to the epilimnetic region.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 10538, 10562, 10670

WATER

REFER ALSO TO CITATION(S) 9727, 9731, 10570, 10694

10591 (DP—1526, pp 129-130) **Plutonium and americium in the sediment of the Savannah River estuary.** Hayes, D.W. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Sediment samples from various locations in the Savannah River estuary were examined for their plutonium, americium, and natural alpha-radiation levels. The americium and plutonium levels represent less than 1% of the gross alpha activity from the naturally occurring radionuclides and do not differ greatly from values reported elsewhere.

10592 (DP—1526, pp 131-134) **Radon-222 in biologically produced gas from a reactor cooling pond.** Fliermans, C.B.; Hayes, D.W.; Johnson, N.D. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Radon-222 emanation rates were obtained from 4 sampling sites with sediment temperatures of 25, 30, 35, and 43°C. The highest discharge rates observed were equivalent to the minimum estimate for the terrestrial flux rate of radon-222.

AQUATIC ECOSYSTEMS AND FOOD CHAINS

10593 (COO—10041-1) **Coral growth rings and the temporal history of nuclear $^{14}C/C$ and $^{90}Sr/Sr$ in the surface ocean. Progress report, February 1, 1979-January 31, 1980.** Broecker, W.S.; Fairbanks, R.G.; Peng, T.H. (Columbia Univ., Palisades, NY (USA). Lamont-Doherty Geological Observatory). Sep 1979. Contract AC02-79EV10041. 12p. Dep. NTIS, PC A02/MF A01.

In addition to sampling the 13 Pacific sites, we have analyzed one coral sample from Bermuda for ^{14}C and ^{90}Sr for the period 1950 to 1973 at 2-year intervals. The high precision ^{90}Sr record from our Bermuda coral shows excellent agreement with historical measurements of ^{90}Sr in surface seawater between 30 to 40°N lat. Therefore, with a high degree of confidence, we can proceed to reconstruct the temporal history of ^{90}Sr in other regions of the world's ocean where we have few or no historical measurements of ^{90}Sr in surface water.

THERMAL EFFLUENTS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 10525

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 9648, 10583

REGULATIONS

REFER ALSO TO CITATION(S) 9653, 10194, 10554

10594 (ANL/EES-TM—70) **Water laws in eleven midwestern states: summary tables.** McNeil, T.L.; Torpy, M.F. (Argonne National Lab., IL (USA)). Jun 1979. Contract W-31-109-ENG-38. 35p. Dep. NTI3, PC A03/MF A01.

Basic information about the water laws of Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio, and West Virginia is summarized. References to state laws and court decisions that may be useful in assessing the legal availability of water for energy development are provided. (MCW)

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

10595 (DOE/EV—T1) **Regional issue identification and assessment. First annual report.** (Department of Energy, Washington, DC (USA). Div. of Regional Assessments). Sep 1979. 876p. Dep. NTIS, PC A99/MF A01.

This regional assessment report portrays the major regional environmental, human health and safety, socioeconomic and institutional effects that might result from the implementation of one of a set of national energy supply and demand projections developed by the Department of Energy in 1978. General problem areas are identified and assessed on a regional and state basis that could either constrain or significantly modify the realization of the energy projections. Many of the issues identified are of a long-standing nature and would continue to exist, in spite of the particular energy projection used. The research and assessments reflected in this document were performed by six national laboratories. It is a compilation of individual reports prepared by Federal regions and available separately.

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 9646, 9702, 10194

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 9759, 9761, 9767, 9770, 9775, 9776, 9856, 10038, 10193, 10563, 10646, 10648

10596 (AECL—6477) **Nuclear risks.** Newcombe, H.B. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Feb 1979. 22p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Estimates of the health effects associated with the use of energy from various sources, including nuclear, fossil, and renewable resources, bear increasingly on the choice between the major energy options, now and in the future. Such comparisons are most appropriately based on the health effects per unit of electrical or other energy produced. They relate importantly to those energy options most likely to replace oil in the future, and they should properly represent the sum of the effects of all steps in the fuel cycles including fabrication and construction. The published comparisons all agree that coal is substantially more hazardous to health than the nuclear fuels, and the one relevant assessment of solar energy places it in an intermediate position. The levels of radiation exposure from nuclear energy are currently minute, and may in the future be expected to equal no more than one tenth the present average exposure from diagnostic radiology on this continent.

10597 (INIS-mf—5088) **Energy and environment. The Ministry of Environment's developmental and planning work in energy and environment. Statement and program.** (Miljoeministeriet, Copenhagen (Denmark)). Dec 1978. 28p. (In Danish). Dep. NTIS (US Sales Only), PC A03/MF A01.

In the note from the Danish Ministry of Environment a presentation is given of the Ministry's projects concerning developmental and planning work in energy and environment. Furthermore the development and planning work in energy and environment is treated under the following headings: Noise from power plants; Use of coal in medium-large plants; Solar energy's entrance into building constructional planning; Coordination of town renewal and energy needs; Town planning. transportation needs, and energy use.

10598 (SERI/TP—33-285, pp 153-161) **Biomass processes systems evaluation and economic analysis.** Katzen, R.; Messick, J.R.; Moon, G.D. Jr. (Raphael Katzen Associates, Cincinnati, OH). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The decision of whether to accept or reject a project for commercialization in the bio-energy field is discussed. The methods for establishing the commercial viability of a proposed venture, the steps for process evaluation, the steps for economic analysis, and the use of working capital are outlined. How to analyze the results of the above parameters, to decide if the project is commercially sound, is discussed.

10599 (SERI/TP—33-285, pp 185-209) **Mission analysis: market penetration modeling. A study of biomass-derived fuels and chemicals likely to achieve US market penetration in the years 1985, 2000, and 2020.** Schooley, F.A. (SRI International, Menlo Park, CA); Dickenson, R.L.; Kohan, S.M.; Jones, J.L.; Meagher, P.C.; Ernest, K.R.; Crooks, G.; Miller, K.A.; Fong, W.S. Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

This study, conducted by SRI International for the US Department of Energy (DOE), Fuels from Biomass Systems Branch, was designed to examine numerous technological processes for producing useful fuels and chemicals from agricultural crops and residues in order to assist DOE in determining the level and type of federal support warranted. Biomass offers a significant potential for reducing national dependence on imported fossil fuels through the conversion of a renewable energy source to useful liquid and gaseous fuels, electric power, process steam and chemicals. Several previous studies have indicated that feasible national goals could be the production of about 5 quadrillion Btu (quads) of energy by year 2000 and 10 quads of energy by the year 2020. The results of this study indicate that these are realistic and achievalbe goals provided federal program funding levels for biomass development are increased and federal incentives are successfully applied to increased biomass feedstock availability. The study involved the identification of over 1,100 possible missions (specific conversion routes from biomass feedstock to useful fuel and chemical products to end-use markets) prior to the selection of 15 missions for detailed analysis.

10600 (SERI/TP—33-285, pp 215-223) **Follow-on studies of the photosynthesis energy factory.** Fraser, M.D.; Henry, J.F.; Barbera, N.J.; Borghi, L.C. (InterTechnology/Solar Corp., Warrenton, VA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

A Photosynthesis Energy Factor (PEF) is an integrated bioconversion system consisting of a dry-land Energy Plantation, a wood-fired power plant, and a wetlands biological wastewater treatment system, such as an algae pond. Products of a PEF are electricity from the power plant, synthetic natural gas from digestion of the wetlands biomass, and reclained wastewater. Effluents and by-products from one system part can be beneficially used by other parts, leading to increased energy conversion and resouce recovery at lower costs. In the initial study a general technoeconomic model was used to investigate possible interactions between the various subsystems. In a second project the PEF model has been expanded and generalized by analyzing possible model improvements in the areas of materials transportation, water and nutrient balances, other types

of wetlands biological systems, and improvements in wood-fired combustion systems. Direct application of municipal wastewater to a dry-land Energy Plantation has been analyzed, also. Potential sites for PEF systems will be evaluated with the improved technoeconomic model.

10601 (SERI/TP—33-285, pp 297-301) **Engineering analysis of anerobic digester concepts.** Ashare, E.; Wilson, E.H. (Dynatech R/D Co., Cambridge, MA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Engineering economic analyses were performed on various digester design concepts to determine the relative performance for different biomass feedstocks. The digester designs included in the analyses are CSTR, plug flow, and batch, and CSTR in series, multistage digestion, and biomethanation were reviewed. Other process options investigated included pretreatment processes such as shredding, degritting, and chemical and thermal pretreatment, and postdigestion processes such as dewatering, and gas purification. The biomass sources considered include feedlot manure, rice straw, and bagasse, with feed rates ranging from 50 to 1000 tons solids/day (4.5 x 10^4 to 9.1 x 10^5 kg solids/day). The results of the analyses indicate that the most economical (on a unit gas cost basis) digester design concept is the plug flow reactor. This conclusion results from this system providing a high gas production rate combined with a low capital hole-in-the-ground digester design concept. The costs determined in this analysis do not include any credits or penalties for feedstock or by-products, but present the costs only for conversion of biomass to methane. The batch land-fill type digester design was shown to have a unit gas cost comparable to that for a conventional stirred tank digester, with the potential of reducing the cost if a landfill site were available for a lower cost per unit volume. The use of chemical pretreatment resulted in a higher unit gas cost, primarily due to the cost of pretreatment chemical. A sensitivity analysis indicated that the use of chemical pretreatment could improve the economics provided a process could be developed which utilized either less pretreatment chemical or a less costly chemical.

10602 **Local control over the onshore impacts of offshore energy development in Florida.** Woodson, R.D.; Corbett, J. Gainesville, FL; University of Florida (1979). 11p. (NP—24223).

Offshore oil and gas development, deepwater ports, shipping of petroleum products, and floating power plants are energy activities which could have great environmental, economic, and social impacts on Florida's coastal communities. The most obvious danger is the potential for oil spills through either the drilling for or transportation of oil. A large oil spill could be particularly devastating for Florida because of the fragile environment and the tourist based economy. However, there are many other impacts which, although not quite as spectacular as an oil spill, can have an equally profound effect on a local community. While energy development occurs offshore, it generates a great deal of onshore development. This onshore development, in turn, is accompanied by additional environmental, economic, and social impacts. These impacts can be either beneficial or detrimental to a local community. Thus, a local government must be aware of pluses and minuses associated with these energy activities in order to effectively respond to any development proposal.

ENVIRONMENTAL IMPACT STATEMENTS

REFER ALSO TO CITATION(S) 9603, 9605, 9606, 10015

BIOMEDICAL SCIENCES, BASIC STUDIES

REFER ALSO TO CITATION(S) 10654

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 9774, 10613, 10614, 10619, 10620, 10621, 10639

10603 (LA—8023-PR, pp 60-95) **Cellular and molecular biology group (H-9).** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Topics discussed are: (1) mutagenicity assessment: nonmetabolic activation of (a) polyaromatic hydrocarbons and liquid steam effluents from oil shale technology and (b) plutonium 238; (2) Photoactivation of polycyclic aromatic hydrocarbons and complex organic mixtures; molecular and cellular studies; (3) reaction of carcinogenic hydrocarbons with model DNAs, (4) covalent binding of benzopyrene derivitives to deoxyribonucleotides of synthetic heteropolymers and studies of DNA repair enzymes; (5) dephosphorylation of histones H1 and H3 during the isolation of metaphase chromosomes; (6) the association of histone deacetylation with chromosome condensation during mitosis; (7) using picolinic acid to investigate the role of iron in cell proliferation; (8) elevated cell-surface hyaluronate in substrate-attached cells; (9) effects of electromagnetic fields on growth and survival of cultured cells; (10) cell resistance to cadmium-mediated toxicity; and (11) complexity and diversity of polysomal and informosomal mRNA from chinese hamster cells. (DC)

10604 (LBL—50-000) **Membrane Bioenergetics Group.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1979. Contract W-7405-ENG-48. 23p. Dep. NTIS, PC A02/MF A01.

The research reported is concerned with the organization and function of membranes as they relate to the transduction of energy by membrane-bound catalysts; and the interaction of environmental pollutants - particularly those that are free radicals. (ACR)

10605 (SERI/TP—33-285, pp 265-274) **Improvement of yields and rates using immobilized enzymes during the hydrolysis of cellulose to glucose.** Klei, H.E.; Sundstrom, D.W.; Coughlin, R.W.; Ziolkowski, K.; Biederman, G. (Univ. of Connecticut, Storrs). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of this paper is to show that the conversion of cellulose to glucose can be increased significantly by enzymatically removing the inhibitory cellobiose from the reaction system using immobilized β-glucosidase (β-G). The enzyme β-G was produced and isolated from Aspergillis phoenicis and was immobilized on Corning controlled-pore alumina by adsorption. Activity retentions upon immobilization have been above 40%. When this enzymatic catalyst was used in a fluidized bed with cellobiose as the only substrate, a 10% loss of activity was observed during a 500 hour period. In other experiments cellulose was hydrolyzed in two batch reactors operated side-by-side, with one reactor containing cellulase, immobilized β-G and cellulose and the other reactor containing no immobilized β-G but otherwise identical. After 30 hours the reactor containing the immobilized β-G had 100% more glucose, indicating that the catalytic removal of the cellobiose had a significant effect upon the production of glucose.

10606 (UR—3490/LCP-17) **Fluorescence quenching studies of the effects of magnesium ion, glucose, viscosity and pH on the structure of yeast hexokinase isozymes.** Norton, G.E. (Rochester Univ., NY (USA). Dept. of Radiation Biology and Biophysics). 1979. Contract EY-76-C-02-3490. 129p. Dep. NTIS, PC A07/MF A01.

Thesis.

Titrations of the tryptophan fluorescence of yeast hexokinase isozymes A and B (HkA and HkB) were performed with Mg^{2+}, Li^+, Na^+, and K^+ ions as titrant in the absence and presence of glucose. Mg^{2+} quenches the fluorescence of surface tryptophan by producing a conformational change which alters the microenvironment of the tryptophan. In the presence of glucose, Mg^{2+} seems to quench more strongly, but the Mg^{2+} enhances the glucose quenching by causing a conformational change which increases the glucose-binding constant. At pH 8.3 Na^+, but not K^+ or Li^+, has a small enhancing effect. Regardless of ionic strength, glucose binding by HkB is noncooperative at pH 8.3 in the presence of any of these four cations and at pH 5.5 in the presence of Mg^{2+} or K^+. Apparent negative cooperativity exists for glucose binding by this isozyme in the presence of Na^+ or Li^+. Glucose binding to HkA in 0.02 M buffer exhibits positive cooperativity at pH 8.3 and 5.5. At pH 5.5 the degree of cooperativity is unchanged by any of these four cations at 0.03 ionic strength, while at pH 8.3 all four cations decrease the degree of cooperativity the same amount. Each cation enhances the glucose-binding strength of HkA at both pH's but to a greater extent at the higher pH. Titrations of the tryptophan fluorescence of HkB were performed with acrylamide as titrant. Acrylamide quenches 100% of the HkB fluorescence at 350 nm. The four tryptophan residues of the monomer subunit can be classified as two surface residues, a glucose-quenchable cleft tryptophan, and a partially buried tryptophan. Binding of the substrate glucose and the cofactor Mg^{2+} induces conformational changes, which are accompanied by alteration of the exposure of the four tryptophans to the quenching action of acrylamide. Acrylamide titrations in the presence of glycerol suggest that transient channels may allow quencher to diffuse to the interior protein matrix. (ERB)

10607 **Induction and persistence of pyrimidine dimers in the epidermal DNA of two strains of hairless mice.** Ley, R.D.; Sedita, B.A.; Grube, D.D.; Fry, R.J.M. (Argonne National Lab., IL). *Cancer Res.*; **37**: 3243-3248(Sep 1977).

The ultraviolet-light induction of DNA damage has been measured in the epidermis of hairless mice with the use of damage-specific endonucleases from Micrococcus luteus. The rates of induc-

tion of endonuclease-sensitive sites in HRS/J/Anl and SKH:hairless-1 mice were 6.1 +- 0.5 x 10^{-11} and 6.5 +- 0.8 x 10^{-11}/dalton/J/sq m from a FS40 fluorescent sun lamp (280 to 400 nm), respectively. Enzymatic photoreactivation with yeast photoreactivating enzyme showed that approximately 80% of the endonuclease-sensitive sites were cyclobutyl pyrimidine dimers. In both strains of mice the pyrimidine dimers remained in high-molecular-weight DNA for 24 hr after irradiation. These data show that mouse epithelial cells in vivo have little or no capacity for the excision repair of pyrimidine dimers.

10608 Electron spin resonance study of radicals produced by one-electron reduction of nicotinic acid, nicotinamide, and methyl nicotinate. Zeldes, H.; Livingston, R. (Oak Ridge National Lab., TN). *J. Magn. Resonance;* **26**: 103-108(1977).

An electron spin resonance study of substituted 1-hydropyridinyl radicals produced by the photolytic reduction of nicotinic acid, nicotinamide, and methyl nicotinate in solutions near room temperature is reported. Spectra were analyzed for the radicals formed by the addition of a hydrogen atom to the ring nitrogen of the parent compounds. The NH-hydrogen couplings of the two former radicals were assigned by studying the spectra in solutions containing D_2O in which some of the NH hydrogens were replaced by deuterium. The couplings are discussed.

10609 Qualitative and quantitative separation of a series of phorbol-ester tumor promoters by high-pressure liquid chromatogaphy. Berry, D.L. (Oak Ridge National Lab., TN); Lieber, M.R.; Fischer, S.M.; Slaga, T.J. *Cancer Lett. (Amsterdam);* **3**: 125-132(1977).

A high-pressure liquid chromatographic (HPLC) method using a microparticulate silica column and gradient elution was developed that separated 12-O-tetradecanoylphorbol-13-acetate (TPA) from 20-oxo-TPA; 12-O-tetradecanoylphorbol (TP); 13-O-acetylphorbol (PA), and from the diterpene alcohol, phorbol (P). A series of other phorbol-ester tumor promoters were also separated via HPLC. Spectrophotometric determination at 232 nm allowed detection sensitivites of 0.05 μg of TPA. When tritiated TPA was applied to mouse skin, the majority of the tritiated product recovered was TPA, indicating only minimal metabolism of TPA and no need for metabolic activation for tumor promotion.

10610 Primer-mediated inhibition of the hydrolysis of template DNA by T5-induced DNA polymerase. Das, S.K. (Univ. of Tennessee, Oak Ridge). *Biochem. Biophys. Res. Commun.;* **79**: No. 1, 247-253(1977).

Bacteriophage T5-induced DNA polymerase has an associated 3′ → 5′ exonuclease activity for which both single-stranded and duplex DNA serve as substrate (1). In this report, we demonstrate that hydrolysis of single-stranded DNA homopolymers (template) is inhibited in the presence of complementary (Watson-Crick sense) oligonucleotides (primer). Almost complete inhibition is observed at a primer/template ratio of ≃ 0.1. Formation of H-bonded primer-template complex seems to be necessary for the inhibition of template hydrolysis because (a) similar amounts of noncomplementary oligonucleotides have no detectable effect on the rate of template hydrolysis, and (b) complementary oligonucleotides lose their inhibitory potential at temperatures where the H-bonded primer-template complex is expected to be unstable. From our data, it appears that the inhibition of template hydrolysis in the presence of primer molecules is due to the preferential binding of the enzyme at the 3′-OH terminus of the primer in the primer-template complex.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 10439, 10642

10611 Partial purification of thrombopoietin from the plasma of thrombocytopenic rabbits. Evatt, B.L.; Levin, J.; Algazy, K.M. (Johns Hopkins Univ. School of Medicine and Hospital, Baltimore, MD). Contract COO-3014-21. *Blood;* **54**: No. 2, 377-388(Aug 1979).

Partially purified thrombopoiesis-stimulating activity was prepared from the plasma of thrombocytopenic rabbits using ammonium sulfate precipitation and DEAE cellulose, Sephadex, and carboxymethyl cellulose chromatography. The protein fraction precipitated by an ammonium sulfate saturation of 60 to 80%, previously shown to contain thrombopoiesis-stimulating activity, was used as starting material. Column chromatography was carried out at room temperature at pH 5.6. Under these conditions, thrombopoiesis-stimulating activity (thromboprotein) was retained by DEAE cellulose (0/03 M citrate-phosphate buffer) and carboxymethyl cellulose (0/003 M citrate-phosphate buffer), and eluted with 0.4 M NaCl. Thrombopoietin was approximately 1000-fold purified following sequential chromatography with DEAE and carboxymethyl cellulose. Although the three fractions described reproducibly stimulated thrombopoiesis, as measured by increased levels of selenome-thionine-^{75}Se (^{75}SeM) in the circulating platelets, platelet counts did not increase.

CYTOLOGY

REFER ALSO TO CITATION(S) 10603, 10604, 10617, 10618, 10643, 10666, 10680

10612 (LA—8023-PR, pp 98-107) Development of flow cytometry instrumentation for rapid cell analysis and sorting. Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Several ongoing research programs dealing with the development of instrumentation for rapid cell analysis and sorting by flow cytometry are summarized. Understanding light scattering with stream in air flow cytometers is discussed. A light-scattering flow photometer is discused and the schematics are included. A statistical approach to the classification of biological cells from their diffraction patterns is presented. New hardware for data acquisition and sorting is diagrammed. An instrument for the measurement of scattered light by individual cells is explained. A parabolic flow cytometer for improving fluorescence sensitivity and resolution is discussed. Verification of cellular dimensions measured by flow cytometry and the implications for cytological diagnosis are discussed. (DC)

10613 (LA—8023-PR, pp 107-122) Biological research. Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Several ongoing research programs dealing with flow-cytometry and cell-sorting technology are summarized. The topics discussed are: flow cytometric analysis of teratocarcinoma cells, flow cytometric quantitation of in vivo pulmonary macrophage phagocytosis, flow analysis by fluorescence of periferal erythrocyte populations, light scattered analysis of periferal leukocyte populations, fluorescence polarization and pulse-width analysis of chromosomes by a flow system, development and evaluation of a rapid two-color staining technique for simultaneous DNA-protein analysis in dual-laser cytophotometry, flow-system analysis of cell kinetics and the effects of a chemotherapeutic drug agent on a model murine colon tumor system, and assessment of the immunologic effects of the by-products of oil shale refining. (DC)

10614 Quantification by DNA-based cytophotometry of the 9q + /22q-chromosomal translocation associated with chronic myelogenous leukemia. Mayall, B.H.; Carrano, A.V.; Moore, D.H. II; Rowley, J.D. (Univ. of California, Livermore). *Cancer Res.;* **37**: 3590-3593(Oct 1977).

DNA-based cytophotometry was used to analyze metaphase chromosomes in four patients with chronic myelogenous leukemia. In three of these patients, both Philadelphia chromosome (Ph^1)-positive and Ph^1-negative cells were measured. On the basis of these three patients, the characteristic 9q + /22q- translocation of chronic myelogenous leukemia involves the net transfer of 0.325% of the autosomal genome; there is no evidence of net gain or loss of DNA (apart from duplication of the Ph^1 chromosome in one patient), and no significant difference is found in the amount of DNA transferred in different patients. Significant differences are found among patients in the derived Chromosomes 9 and the Ph^1 chromosomes and are ascribed to preexisting variations in the Ph^1-negative cells of these patients. There is no evidence in these patients of any further cytogenetic lesion associated with chronic myelogenous leukemia.

10615 Qualitative changes in immunocompetent cells with age: reduced sensitivity to cortisone acetate. Popp, D.M. (Oak Ridge National Lab., TN). *Mech. Ageing Dev.;* **6**: 355-362(1977).

Recent studies suggest that immunocompetent cells that respond to primary antigenic stimulus in old mice are different cell types from those that respond in young mice. This hypothesis was tested by determining the cortisone acetate sensitivity of antigen-sensitive lymphocytes from young and old donors. It was found that antigen-reactive lymph node lymphocytes from young donors are cortisone-acetate sensitive whereas the antigen-reactive lymph node lymphocytes from old donors are cortisone-acetate resistant.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 10439

10616 Method for combined ^{3}H and ^{14}C autoradiography with a single emulsion tested in cultured mammalian cells. Perdue, S.W.; Kimball, R.F.; Hsie, A.W. (Oak Ridge National Lab., TN). *Exp. Cell Res.;* **107**: 47-54(1977).

A single-gelatin expanded film method for double-isotope autoradiography is described. A preliminary classification based upon silver-grain distribution is used to assign labeled cells to ^{3}H only or with ^{14}C classes. Optical sectioning combined with grain counting is employed to obtain ratios for classifying cells labeled with ^{14}C into ^{14}C only and ^{3}H + ^{14}C classes. The method has been

tested with CHO-K1 cells in plateau-phase cultures using two 24-h labeling periods. The experimental design allowed for independent estimation of the expected frequencies of label classes under conditions that provided a wide range of possible label levels and combinations. Previous methods have used time-consuming applications of two emulsion layers and exposures to distinguish between cells labeled with ^{3}H only or with ^{14}C and do not identify the $^{3}H + {}^{14}C$ class. A single-gelatin expanded film requires only one exposure and permits all label classes to be determined by an objective grain-counting procedure.

GENETICS

REFER ALSO TO CITATION(S) 10638, 10668

10617 (CONF-780411—) **Propagation of higher plants through tissue culture: a bridge between research and application.** Hughes, K.W.; Henke, R.; Constantin, M. (eds.). (Tennessee Univ., Knoxville (USA). Dept. of Botany; UT-ERDA Comparative Animal Research Lab., Oak Ridge, TN (USA)). 1978. 315p. Dep. NTIS, PC A14/MF A01.

From 15. numerical control conference; Chicago, IL, USA (9 Apr 1978).

The use of tissue culture in the propagation of higher plants was discussed. Recent advancements in this field were reported. The use of this method to study basic mechanisms of morphogenesis as well as its economic implications in horticulture and agriculture were discussed. (DC)

10618 (CONF-780411—, pp 1-10) **Keynote address. Propagation of higher plants through tissue culture: a bridge between research and application.** Jaworski, E.G. (Monsanto Co., St. Louis, MO). 1978.

From 15. numerical control conference; Chicago, IL, USA (9 Apr 1978).

A history of plant propagation through tissue culture is presented. Some of the areas requiring future emphasis in this subject from scientific and technical aspects are discussed. Some areas are: cloning, organogenesis, genetic selection, uptake of growth regulating hormones, development of diagnostic and analytical tools, plant hormone analysis, behavior of nutrients, protoplast isolation and DNA studies, transfer of genes from other organisms into plants, the study of regulatory processes in photosynthesis, photorespiration, and photomorphogenesis.

MEDICINE

REFER ALSO TO CITATION(S) 9682, 10615, 10622

10619 (ORNL/BCTIC—1/R1(Rev.)) **Directory of computer users in nuclear medicine.** Erickson, J.J.; Gurney, J.; McClain, W.J. (eds.). (Oak Ridge National Lab., TN (USA)). Sep 1979. Contract W-7405-ENG-26. 226p. Dep. NTIS, PC A11/MF A01.

The Directory of Computer Users in Nuclear Medicine consists primarily of detailed descriptions and indexes to these descriptions. A typical Installation Description contains the name, address, type, and size of the institution and the names of persons within the institution who can be contacted for further information. If the department has access to a central computer facility for data analysis or timesharing, the type of equipment available and the method of access to that central computer is included. The dedicated data processing equipment used by the department in its nuclear medicine studies is described, including the peripherals, languages used, modes of data collection, and other pertinent information. Following the hardware descriptions are listed the types of studies for which the data processing equipment is used, including the language(s) used, the method of output, and an estimate of the frequency of the particular study. An Installation Index and an Organ Studies Index are also included. (PCS)

10620 **Effects of metformin on lipoprotein composition in rabbits and man.** Sirtori, C. (Univ. of Milan, Italy); Catapano, A.; Ghiselli, G.C.; Shore, B.; Shore, V. Contract W-7405-ENG-48. pp 379-383 of Protides of the biological fluids. Peeters, H. (ed.). New York, NY; Pergamon Press (1978).

Administration of metformin to cholesterol-fed rabbits markedly reduces atheromatosis without significantly modifying plasma cholesterol levels. Cholesterol-rich lipoproteins ($d < 1.019$) show a significant reduction of the arginine-rich protein after metformin and the presence of apoprotein(s) similar to or idential with serum albumin. Albumin increased in the chylomicrons and lipoproteins of very low, intermediate, low and high density with time from two weeks to one year. Preliminary clinical and biochemical observations in patients with type III hyperlipoproteinemia suggest that metformin causes similar changes in their apoproteins. Metformin administration to cholesterol-fed rabbits may provide an experimental model for the study of cholesterol-rich nonatherogenic lipoproteins.

10621 **Effects of varying the onset and duration of exposure to phenobarbital on its enhancement of 2-acetylaminofluorene-induced hepatic tumorigenesis.** Peraino, C.; Fry, R.J.M.; Staffeldt, E. (Argonne National Lab., IL). *Cancer Res.;* 37: 3623-3627(Oct 1977).

In previous experiments we observed that the short-term feeding of 2-acetylaminofluorene (AAF) at a low dietary concentration resulted in the late appearance of well-differentiated hepatic tumors at low incidence levels. When the AAF treatment was followed by the feeding of a phenobarbital-supplemented diet, the appearance of these tumors was accelerated, and their overall incidence levels were increased. The present study examined the characteristics of this interaction between the effects of AAF and phenobarbital by measuring tumor production after changing either the duration of the interval between AAF and phenobarbital treatments or the duration of the post-AAF exposure to phenobarbital. When AAF and phenobarbital treatments were separated by increasing intervals (up to 120 days), the resultant levels of tumor enhancement appeared to be influenced mainly by the duration of the post-AAF phenobarbital treatment rather than by the length of the treatment-free interval. Progressive increases in the duration of the phenobarbital treatment (begun within 7 days after the AAF treatment) advanced the time at which tumor enhancement occurred and similarly increased overall tumor incidence levels. The latter enhancement effects occurred and were sustained after the cessation of the phenobarbital treatments. The results of this study suggest that (a) the tumorigenic changes induced by brief AAF treatment are persistent, although the question of their permanence remains open, and (b) phenobarbital treatment produces irreversible changes in AAF-modified cells, which lead to the expression of the tumor phenotype.

UNSEALED RADIONUCLIDES IN DIAGNOSTICS

REFER ALSO TO CITATION(S) 10407, 10641

10622 (AD-A—064465) **Radiologic, medical laboratory and nuclear medicine career ladders AFSCS 90330, 90350, 90370, 90390, 90430, 90450, 90470, 90492, 90930, 90970, and 90999. Occupational survey report.** (Air Force Occupational Measurement Center, Randolph AFB, TX (USA)). 31 Dec 1978. 55p. NTIS PC A04/MF A01.

This is a report of an occupational survey of personnel in the Radiologic, Medical Laboratory, and Nuclear Medicine career ladders completed by the Occupational Survey Branch, USAF Occupational Measurement Center, during December 1978. This report is one of three prepared for the Classification Branch of the Air Force Manpower and Personnel Center (AFMPC/MPCRPQ) upon their request for occupational data on selected AFSCs within the Medical career field 'to determine if the current classification structure is adequate.' In this study, AFS 909X0, Nuclear Medicine Technician was surveyed in conjunction with AFSCs 903X0 and 904X0 since personnel entering the Nuclear Medicine career ladder must first possess at least a 5-skill level in either the Radiologic or Medical Laboratory career ladders. This implies similar skill knowledge requirements and makes these three specialties logical candidates for possible consolidation.

10623 (ANL—79-XX-99) **New radionuclide generator systems for use in nuclear medicine.** Atcher, R.W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 179p. Dep. NTIS, PC A09/MF A01.

Thesis.

A current emphasis in nuclear medicine is to better match the physical lifetime of the radionuclides used in vivo for diagnosis and treatment to the biological lifetime of the diagnostic procedure or to minimize radiation dose to areas other than those to be treated. In many cases the biological lifetime is on the order of minutes. Since the direct production of radionuclides with half lives of minutes requires the user to be near a suitable reactor or accelerator, this study was undertaken to produce short-lived radionuclides indirectly. If a long-lived radionuclide decays into a short-lived radionuclide, quick separation of the daughter activity from the parent enables the user to have a short-lived daughter while freeing him from the constraint of proximity to a cyclotron. Systems where a short-lived daughter is separated from a long-lived parent are called radionuclide generators. Two generator systems were developed for use in nuclear medicine, one in diagnostic work and the other for therapeutic work. The yield and breakthrough characteristics were within the limits required to minimize unnecessary radiation exposure in patients. Two parent radionuclides were produced using ^{4}He beams available from medium energy cyclotrons. The yield was high enough to produce generators that would be useful in clinical applications.

10624 **Thallium-201 myocardial imaging: a comparison of the redistribution and rest images.** Ritchie, J.L.; Albro, P.C.; Caldwell,

J.H.; Trobaugh, G.B.; Hamilton, G.W. (Univ. of Washington, Seattle). *J. Nucl. Med.;* **20**: No. 6, 477-483(Jun 1979).

Forty-one patients with chest pain and suspected coronary artery disease underwent thallium-201 myocardial imaging, performed immediately following maximal treadmill exercise, also at redistribution 4 to 5 hr after exercise, and at rest 1 wk later. All had coronary angiography. All images in seven patients without coronary artery disease were normal. Twenty-seven of the 34 (79%) patients wih coronary artery disease had new, exercise-induced image defects. The redistribution and rest images were identical in 15/27 (56%) patients (complete redistribution). In 10/27 (37%) patients with exercise-induced defects, some redistribution occurred but defect size on the redistribution image was larger than that on the rest images (incomplete redistribution). In 2/27 (7%) of patients with exercise-induced defects, redistribution was absent. The presence of prior myocardial infarction, regional abnormalities of left-ventricular contraction or the severity of coronary stenoses did not correlate with the presence or absence of redistribution. Overall image quality between the two studies was similar, although image collection times for the redistribution study were prolonged. It is concluded that some redistribution (complete or incomplete) occurs in most patients with exercise-induced image defects. When both fixed and reversible perfusion defects are present, defect size was often larger in the redistribution image and may thus overestimate the extent of prior myocardial infarction.

10625 Validity of left-ventricular ejection fractions measured at rest and peak exercise by equilibrium radionuclide angiography using short acquisition times. Pfisterer, M.E.; Ricci, D.R.; Schuler, G.; Swanson, S.S.; Gordon, D.G.; Peterson, K.E.; Ashburn, W.L. (Univ. of California Medical Center, San Diego). *J. Nucl. Med.;* **20**: No. 6, 484-490(Jun 1979).

To validate ejection fraction (EF) calculations from 5 and 2 minutes of multiple-gated equilibrium radionuclide angiographic data and to establish its utility during alterations in cardiac performance, we studied 38 patients with chest pain suggestive of coronary artery disease. Twenty-four patients underwent contrast ventriculography (CV) as well as first-pass (FP) and equilibrium (EQ) radionuclide angiography at rest, and 14 additional patients had both radionuclide tests performed at rest as well as during peak supine bicycle exercise. The resting 5-min acquisition ejection fractions were compared between each method and the following correlations were generated: $r = 0.92$, $n = 24$ (CV-EQ), $r = 0.92$, $n = 24$ (CV-FP), and $r = 0.95$, $n = 38$ (FP-EQ). The variability of EQ-EF calculations between two independent observers was $< 2\%$; the mean absolute difference between two sequential 2 min acquistions and the 5 min recordings was -0.1 +- 1.6%, and the reproducibility of sequential 2-min ejection fractions was excellent ($r = 0.98$). EQ and FP ejection fractions at symptom-limited exercise correlated well ($r = 0.96$, $n = 14$). We conclude that equilibrium radionuclide angiography is a valid method to measure EF both at rest as well as during peak exercise even when 2-min acquisition periods are used.

10626 Reproducibility of ejection-fraction determinations by equilibrium radionuclide angiography in response to supine bicycle exercise: concise communication. Pfisterer, M.E.; Battler, A.; Swanson, S.M.; Slutsky, R.; Froelicher, V.; Ashburn, W.L. (Univ. of California Medical Center, San Diego). *J. Nucl. Med.;* **20**: No. 6, 491-495(Jun 1979).

Sixteen patient with stable, chronic coronary artery disease were studied twice within an average of 15 days to evaluate the reproducibility of ejection fraction (EF) determined by equilibrium radionuclide angiography (EQ) at rest, during supine bicycle exercises (ex), and in the recovery period (rec). Following injection of 20 to 25 mCi of 99m Tc-tagged human serum albumin, data were analyzed for 2 min periods at rest, during several stages of exercise (submax, max), and during recovery (rec_1 = minutes 2 + 3, rec_2 = minutes 9 + 10). Each patient reached similar (heart rate) times (blood pressure) products in the two studies: 21,280 +- 5200 compared with 20,390 +- 4140 mmHg/min. Mean EFs for the first and second studies were: at rest (53.0 +- 10.8)%, (52.5 +- 10.4)% ($r = 0.95$); submax ex (51.4 +- 12.0)%, (52.1 +- 12.8)% ($r = 0.91$); max ex (50.6 +- 12.6)%, (51.6 +- 12.9)% ($r = 0.97$); rec_1 (62.7 +- 11.6)%, (62.4 +- 12.2)% ($r = 0.95$); rec_2 (55.5 +- 10.8)%, (57.2 +- 11.7)% ($r = 0.91$). In stable patients, the reproducibility of EF determined by EQ is excellent during rest, supine bicycle exercise, and recovery from exercise.

10627 Use of blood-pool imaging in evaluation of diffuse activity patterns in technetium-99m pyrophosphate myocardial scintigraphy. Cowley, M.J.; Mantle, J.A.; Rogers, W.J.; Russell, R.O. Jr.; Rackley, C.E.; Logic, J.R. (Univ. of Alabama Medical Center, Birmingham). *J. Nucl. Med.;* **20**: No. 6, 496-501(Jun 1979).

It has been suggested that diffuse 99m Tc pyrophosphate precordial activity may be due to persistent blood-pool activity in routine delayed views during myocardial imaging. To answer this question, we reviewed myocardial scintigrams recorded 60 to 90 min following the injection of 12 to 15 mCi of 99m Tc pyrophosphate for the presence of diffuse precordial activity, and compared these with early images of the blood pool in 265 patients. Diffuse activity in the delayed images was identified in 48 patients: in 20 with acute myocardial infarction and in 28 with no evidence of it. Comparison of these routine delayed images with early views of the blood pool revealed two types of patterns. In patients with acute infarction, 95% had delayed images that were distinguishable from blood pool either because the activity was smaller than the early blood pool, or by the presence of localized activity superimposed on diffuse activity identical to blood pool. In those without infarction, 93% had activity distribution in routine delayed views matching that in the early blood-pool images. The usefulness of the diffuse TcPPi precordial activity in myocardial infarction is improved when early blood-pool imaging is used to exclude persistence of blood-pool activity as its cause. Moreover, it does not require additional amounts of radioactivity nor complex computer processing, a feature that may be of value in the community hospital using the technique to rule out infarction 24 to 72 hr after onset of suggestive symptoms.

10628 Deconvolution analysis in radionuclide quantitation at left-to-right cardiac shunts. Alderson, P.O.; Douglass, K.H.; Mendenhall, K.G.; Guadiani, V.A.; Watson, D.C.; Links, J.M.; Wagner, H.N. Jr. (Johns Hopkins Medical Institutions, Baltimore, MD). *J. Nucl. Med.;* **20**: No. 6, 502-506(Jun 1979).

A poor bolus injection results in an unsatisfactory quantitative radionuclide angio-cardiogram in as many as 20% of chiledren with possible left-to-right (L-R) cardiac shunts. Deconvolution analysis was applied to similar studies in experimental animals to determine whether dependence on the input bolus could be minimized. Repeated good-bolus, prolonged (> 2.5 sec), or multiple-peak injections were made in four normal dogs and seven dogs with surgically created atrial septal defects (ASD). (QP/QS was determined using the gamma function. The mean (QP/QS from ten good-bolus studies in each animal was used as the standard for comparison. In five trials in normal animals, where a prolonged or double-peak bolus led to a shunt calculation QP/QS > 1.2:1), deconvolution resulted in QP/QS = 1.0. Deconvolution improved shunt quantitation in eight of ten trials in animals that received a prolonged bolus. The correlation between the reference QP/QS and the QP/QS calculated from uncorrected bad bolus studies was only 0.39 ($p > 0.20$). After deconvolution using a low pass filter, the correlation improved significantly ($r = 0.77$, $p < 0.01$). The technique gave inconsistent results with multiple-peak bolus injections. Deconvolution analysis in these studies is useful in preventing normals from being classified as shunts, and in improving shunt quantitation after a prolonged bolus. Clinical testing of this technique in children with suspected L-R shunts seems warranted.

10629 Carbon-11-labeled amino acids for the rectilinear and positron tomographic imaging of the human pancreas. Huebner, K.F.; Andrews, G.A.; Buonocore, E.; Hayes, R.L.; Washburn, L.C.; Collmann, I.R.; Gibbs, W.D. (Oak Ridge Associated Universities, TN). Contract EY-76-C-05-0033. *J. Nucl. Med.;* **20**: No. 6, 507-513(Jun 1979).

Modification of the Buecherer-Strecker amino acid synthesis facilitated the production of DL-[^{11}C]tryptophan and DL-[^{11}C]valine for clinical trials in patients with proven or suspected pancreatic disease. Examples of rectilinear scans and tomographic images of the pancreas are presented in this initial paper. Positron computed tomography was done with the ORTEC ECAT system. Rapid localization of these C-11-labeled amino acids and fast clearance from the plasma permit almost immediate examination following i.v. injection. Illustrative images include the normal pancreas, pancreatitis, and pancreatic carcinoma. The use of positron tomography with C-11-labeled DL-tryptophan and DL-valine appears to offer a new and promising diagnostic modality for the detection and study of pancreatic diseases.

10630 Measurement of liver volume by emission computed tomography. Kan, M.K.; Hopkins, G.B. (Scripps Memorial Hospital, La Jolla, CA). *J. Nucl. Med.;* **20**: No. 6, 514-520(Jun 1979).

In 22 volunteers without clinical or laboratory evidence of liver disease. liver volume was determined using single-photon emission computed tomography (ECT). This technique provided excellent object contrast between the liver and its surroundings and permitted calculation of liver volume without geometric assumptions about the liver's configuration. Reproducibility of results was satisfactory, with a root-mean-square error of less than 6% between duplicate measurements in 15 individuals. The volume measurements were validated by the use of phantoms.

10631 Adrenal hemorrhage in the newborn: scintigraphic diagnosis. Heyman, S.; Treves, S. (Harvard Medical School, Boston, MA). *J. Nucl. Med.;* **20**: No. 6, 521-523(Jun 1979).

Four neonates with abdominal masses following adrenal hemorrhages were investigated by renal scintigraphy. Characteristic photon-deficient lesions were noted in the suprarenal areas during the phase of whole-body radionuclide distribution.

10632 Scintigraphic imaging with tantalum-178 and the Anger scintillation camera: concise communication. Holman, B.L.; Zimmerman, R.E.; Bifolck, L.V.; Neirinckx, R.D. (Harvard Medical School, Boston, MA). Contract EY-76-S-4115. *J. Nucl. Med.;* **20**: No. 6, 538-542(Jun 1979).

Tantalum-178 is a short-lived radionuclide (T/sub 1/2/ = 9.3 min.) and emits primarily 56- to 64-keV characteristic x-rays. We have determined the imaging characteristics with this radionuclide and a large-field-of-view Anger camera. With a pinhole collimator, good spatial resolution is possible with Ta-178, although the image quality is superior with Tc-99m under comparable conditions. Spatial resolution with parallel-hole or converging collimators was much less satisfactory with Ta-178 because of septal penetration by high-energy photons. Pulmonary perfusion and liver-spleen images of excellent quality were obtained in the rabbit using the pinhole collimator and Ta-178-labeled agents.

10633 Growth-hormone and somatostatin effects on [^{75}Se]selenomethionine uptake by the pancreas. Atkins, H.L.; Som, P. (Brookhaven National Lab., Upton, NY). *J. Nucl. Med.;* **20**: No. 6, 543-546(Jun 1979).

The imaging of the pancreas with [^{75}Se]selenomethionine has a low rate of reliability. This study was carried out in order to elucidate some factors that may be important in affecting the degree of uptake of the tracer by the pancreas. Studies were carried out in animals to observe the effects of growth-hormone (GH), somatostatin (SRIF), L-DOPA, and apomorphine administration on the distribution of [^{75}Se]selenomethionine. Intravenously administered GH significantly depressed pancreatic uptake of Se-75 in mice and dogs and depressed the pancreas-to-liver concentration ratio (P/L). The effect of i.p. GH in mice was to decrease the P/L ratio, but the decrease in pancreatic uptake was not statistically significant. There was also a greater effect of GH in dogs than in mice, with pancreatic uptake decreasing from 5.60 +- 2.17% to 1.24 +- 0.96% and the P/L from 4.78 +- 1.85 to 0.97 +- 0.73. L-DOPA and apomorphine produced effects similar to GH in mice. SRIF in small doses had little effect, but in larger doses it enhanced pancreatic uptake, although not affecting P/L. The results indicate that hypothalamic factors may be important in affecting the function of the exocrine pancreas. Both L-DOPA and apomorphine are known to stimulate GH production through hypothalamic-pituitary pathways. In addition to suppressing GH release, SRIF may have direct effects on the exocrine pancreas.

10634 Dynamic phantom for radionuclide cardiology. Nickles, R.J. (Univ. of Wisconsin, Madison). *J. Nucl. Med.;* **20**: No. 6, 547-549(Jun 1979).

A flow-based phantom has been developed to verify analysis routines most frequently employed in clinical radionuclide cardiology. Ejection-fraction studies by first-pass or equilibrium techniques are simulated, as well as assessment of shunts and cardiac output. This hydraulic phantom, with its valve-selectable dysfunctions, offers a greater role in training than in quality control, as originally intended.

10635 Combination of sensitizers with high LET radiations. Raju, M.R.; Amols, H.I.; Carpenter, S.G. (Los Alamos Scientific Lab., NM). *Br. J. Cancer;* **37**: 189-195(1978).

Preliminary measurements of OER for pion beams in combination with a concentration of Misonidazole (0.4 mM) that is realistic in radiotherapeutic application are reported. These results indicate that 0.4 mM of misonidazole is as effective in reducing OER for negative pions as for x-rays. The application of high LET radiations in combination with hypoxic cell sensitizers is discussed.

10636 Magnification film mammography: image quality and clinical studies. Sickles, E.A. (Univ. of California, San Francisco); Doi, K.; Genant, H.K. *Radiology;* **125**: 69-76(Oct 1977).

From 61. scientific assembly and annual meeting of the Radiological Society of North America; Chicago, IL, USA (30 Nov 1975).

Direct radiographic magnification (1.5 +) of the breast with a microfocus x-ray tube was compared with conventional contact mammography. Measurements of modulation transfer functions, Wiener spectra, scattered radiation, and dosimetry permitted quantitative comparisons of resolution, noise, contrast, and patient exposure. Images of surgical specimens of the breast, and the breasts of 125 patients, were qualitatively compared. Magnification images were superior (increased resolution, reduced noise) to conventional mammography images, at the expense of increased radiation dose. Clinical study revealed that the superior magnification image is useful in distinguishing malignant from benign breast disease, in selected cases.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 9771, 9773, 9774, 9847, 9848, 9850, 10605

10637 (SERI/TP—33-285, pp 25-32) Bioengineering aspects of inorganic carbon supply to mass algal cultures. Goldman, J.C. (Woods Hole Oceanographic Inst., MA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The study involves a thorough investigation of the inorganic carbon requirements of algae (both micro and macro species) under mass culture conditions. Major research topics considered include: (1) the growth kinetics of various freshwater and marine algae under inorganic limitation at different pH levels; (2) comparisons of growth with bubbled CO_2 and HCO_3^- alkalinity as inorganic carbon sources at varying pH levels; (3) effects of pH on algal growth under non-carbon limiting conditions; (4) effects of mixing in inorganic carbon limiting and non-limiting situations on algal growth; (5) growth kinetics under carbon saturation but light limitation. Based on results to date, it appears that certain marine microalgae appear to be far more tolerant of high pH (> 9) than other species. HCO_3^-, if supplied in excess and with proper pH control, can meet the inorganic carbon requirements of marine algae. Efficiency of use is 90% at HCO_3^- concentrations four times greater than in natural seawater. Based on the growth kinetics of fresh water green algae under HCO_3^- limitation, virtually 100% assimilation is possible at all growth rates up to just before cell washout. Hence, maximum yields under carbon limitation occur at very high growth rates. In addition, it has been shown that the supply and mass transfer rates of gaseous carbon dioxide rather than the concentration of carbon dioxide in the gas mixture is the critical factor in ensuring an adequate supply of inorganic carbon.

10638 (SERI/TP—33-285, pp 85-89) Improvements in cellulase production by Trichoderma through mutation and selected breeding. Montenecourt, B.S.; Schamhart, D.H.J.; Cuskey, S.M.; Eveleigh, D.E. (State Univ. of New Jersey, New Brunswick). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Efficient conversion of cellulose to glucose syrups is a prerequisite if biomass is to be counted as a viable starting material for fuels. Biochemical conversion employing cellulase enzymes offer several advantages over the traditional acid hydrolysis as enzymes are non-polluting, resuable, require low energy input while catalyzing high conversion efficiencies into a pure glucose product. Enzymatic conversion has not been achieved commercially due to the high costs of the cellulases from the available microbial strains. The major focus of this program is to lower the cost of these enzymes through the isolation of mutant strains which synthesize the cellulase in high yields and catalyze more efficient conversion of the cellulose to glucose. A number of selective screening methods have been devised that allow detection of mutants of Trichoderma reesei which are capable of overcoming the biochemical and genetic controls operative during cellulase synthesis and activity. Selected breeding is being developed employing the parasexual cycle and protoplast fusion in order to sequester desired characteristics into a single strain. Current emphasis in the program has been to characterize these mutants especially in relation to their industrial usefulness.

10639 Mechanism of phage phi X174 DNA inactivation by benzo[a]pyrene-7,8-dihydrodiol-9,10-epoxide. Hsu, W.T.; Lin, E.J.S.; Harvey, R.G.; Weiss, S.B. (Univ. of Chicago, IL). *Proc. Natl. Acad. Sci. U.S.A.;* **74**: No. 8, 3335-3339(Aug 1977).

A previous report from this laboratory has shown that certain derivatives of polycyclic aromatic hydrocarbons bind to phi X174 DNA and render it noninfectious. The present work describes the relationship between the extent of phi X174 DNA binding by (+-)-anti-benzo[a]pyrene-7,8-dihydrodiol-9,10-epoxide and the effect on infectivity. The results suggest that one molecule of bound diolepoxide is sufficient to inhibit the replication of a single molecule of phi X174 DNA. DNA synthesis studies, in vitro, indicate that when phi X DNA bound by benzo[a]pyrene groups serves as template the rate of DNA polymerization is reduced and less product is formed. In addition, the propagation of synthetic DNA strands is blocked so that incomplete complementary chains are assembled. The relationship of these findings to the mutagenic and carcinogenic process associated with the action of benzo[a]pyrene-diol-epoxide is discussed.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 10615, 10652

10640 (LA—8023-PR, pp 27-32) Immunology studies. Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Three efforts dealing with the role of the immune state have continued to show promise over the last year. The first deals with the development of animal models for testing the part played by immune dysfunction in carcinogenesis. The second and related pro-

gram is a clinical study of high-risk uranium miners whose status in relation to neoplastic manifestations is rather well-defined. The third program is one in which fetal tissue is used to attempt the rescue of lethally irradiated hosts.

TRACER TECHNIQUES

10641 Labeling of human platelets with [^{111}In] 8-hydroxyquinoline. Scheffel, U.; Tsan, M.F.; McIntyre, P.A. (Johns Hopkins Medical Institutions, Baltimore, MD). *J. Nucl. Med.;* **20**: No. 6, 524-531(Jun 1979).

We have evaluated the factors influencing the labeling of human platelets in the presence of autologous plasma. The labeling efficiency was found to be dependent on a) the time and temperature of incubation, b) the platelet concentration, c) the concentration of citrate ions (in ACD anticoagulant), and d) the concentration of 8-hydroxyquinoline in the suspending medium. Contrary to what was expected, unsaturated transferrin was found not to interfere with the transfer of In-111 from the [^{111}In] 8-hydroxyquinoline complex to the platelets. Based on the findings of this study, a protocol was established by which human platelets can be labeled with In-111 in plasma with a labeling efficiency of 55.5 +- 9.3 (mean +- 1 s.d.) percent.

10642 Portable, temperature-controlled, steady-state porometer for field measurements of transpiration and photosynthesis. Bingham, G.E.; Coyne, P.I. (Univ. of California, Livermore). *Photosynthetica;* **11**: No. 1, 148-160(1977).

A new system for photosynthesis and transpiration measurements incorporates several features available for the first time in a single unit. These are a temperature-controlled exposure chamber adaptable to all leaf types, the capability for near-simultaneous measurements of transpiration and photosynthesis on both sides of the leaf, and back-pack portability. The system uses $^{14}CO_2$ for photosynthesis measurements. Humidity is controlled by steady-state porometer techniques. Adaptability to different leaf morphologies is given by two interchangeable heads. The ventilated, temperature-controlled heads allow the system to be used for studies of transpiration and photosynthesis with controlled conditions. The system was field-tested on Pinus ponderosa Laws, in the San Bernardino National Forest.

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 10686

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 9770, 9856, 9956, 10201, 10562, 10617, 10618, 10681, 11032

10643 (CONF-780411—, pp 11-13) **In vitro propogation, impact and potential. Historical perspectives and introduction.** Constantin, M.J. (Comparative Animal Research Lab., Oak Ridge, TN). 1978.

From 15. numerical control conference; Chicago, IL, USA (9 Apr 1978).

The history of agriculture is briefly described. The history of man's effort to culture plant cells and tissues in vitro dates back to the 1800's. Some of the early successes in the tissue culture of plants are discussed.

10644 (INKA-Conf—78-021-000) **German food chemists' day 1978. Abstracts.** (Gesellschaft Deutscher Chemiker, Frankfurt am Main (Germany, F.R.). Fachgruppe Lebensmittelchemie und Gerichtliche Chemie). 1978. vp. (In German). (INKA-Conf—78-021-001; CONF-7809179—(Absts.)). Fachinformationszentrum Karlsruhe, Germany.

From German food chemists; day 1978: the importance of university research for food chemistry; Hamburg, F.R. Germany (13 Sep 1978).

Individual abstracts were prepared (PCS)

10645 (SERI/TP—33-285, pp 47-51) **Increasing the biomass production of short rotation coppice forests.** Steinbeck, K. (Univ. of Georgia, Athens). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The objective of this project is to evaluate various ways of increasing the biomass yields from short-rotation coppice forests established for energy production. To this end several hardwood species are being evaluated for their potential as biomass producers and growth responses to weed control, mechanical cultivation, fertilization, and irrigation are determined. Desirable provenances and individuals of candidate species are selected and tissue culture techniques for mass cloning are being developed. Two 16 hectare plantations have been established on contrasting sites with soils that may be available for short-rotation forestry. Plantanus occidentalis, Liquidambar styraciflua, Alnus glutinosa and Robinia pseudoacacia were planted in early 1978 and 1979 either in pure stands or in mixtures of Plantanus or Liquidambar with one of the other two species, which are nitrogen fixers. The growth, energy input-output and nutrient status of these plantations is monitored. First seedling harvests are expected in 1981 and coppice rotations will then be initiated.

10646 (SERI/TP—33-285, pp 229-236) **Carbohydrate crops as sources of fuels.** Lipinsky, E.S. (Battelle Columbus Labs., OH). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

Evaluation of yields and costs of sweet sorghum and sugarcane production using narrow interrow spacing yielded favorable results leading to a tentative go decision for development of sweet sorghum as an energy crop. Sugarcane's limited geographical range relegates it to a secondary position for now. Experimental production of sweet sorghum is being expanded into North Dakota (long day length and short growing season) and into Kansas and Nebraska drylands. Farm Bureau trials in Illinois, Iowa, and Ohio will test farmer acceptance. Grain sorghum-sweet sorghum hybrids to stretch the fermentation season are being evaluated. The benefits of narrow interrow spacing necessitate the development of integrated planting, harvesting, processing, storage, and conversion systems. Developments outside the scope of this paper are underway in these areas.

10647 (SERI/TP—33-285, pp 237-243) **Analysis and design of a pilot silvicultural biomass farm at the Savannah River Plant.** Salo, D.J.; Henry, J.F. (MITRE Corp., McLean, VA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

In support to the Fuels from Biomass Systems Branch, MITRE/Metrek has developed an implementation plan for the installation and operation of a Pilot Silvicultural Biomass Farm of about 600 acres at the Savannah River Plant, South Carolina. The project included a comparative assessment of designs using either a trickle irrigation system or a traveling sprinkler system. Installation costs, operating costs, biomass production costs, net energy efficiency and sensitivity to design parameters were compared for the two designs. The trickle irrigation system is recommended for the Savannah River project: installation costs for this system are estimated to be $1.1 million, operating costs are estimated at $7.5 million for the 23 year lifetime of the project, biomass production cost is projected to be $2.25/MM Btu for a large scale farm based on the Savannah River project design and the net energy efficiency is estimated to be 0.91. The selection of the trickle system results from site specific conditions at the Savannah River Plant which may not be found elsewhere.

10648 (SERI/TP—33-285, pp 245-254) **Herbaceous species screening program. Phase I.** Saterson, K.A.; Luppold, M.K. (Arthur D. Little, Inc., Cambridge, MA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The overall objective of the DOE Fuels From Biomass Herbaceous Species Screening Program is to identify the herbaceous plant species that might be the most promising candidates for biomass production in approximately six different regions of the United States (Phase I) and to then conduct field screening on each species in order to recommend the most promising species for future research and development (Phase II). The United States was divided into ten regions, based on the SCS Land Resouces Areas, and the six that appear to offer the most potential for commercial biomass production were identified. A literature review and field interviews generated a list of 280 promising species, on which botanical and economic screenings were conducted. The result of the screening is a list, for each region, of up to 20 species that appear to have potential for high biomass productivity and which should be considered for inclusion in Phase II field screening. A total of 70 different species were included in the regional lists.

10649 (SERI/TP—33-285, pp 359-365) **Research and development of intensively cultured plantations for maximum biomass production.** Dawson, D.H. (North Central Forest Experimental Station, Rhinelander, WI). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

To establish trees and ensure their survival are the most critical problems in the intensive culture system because larger research studies or large-scale industrial plantations cannot be established until the technology to successfully establish hardwood stands has been developed. Briefly, the intensive culture concept is that tree yield can be greatly increased by using genetically superior planting material and optimizing field environmental conditions. Generally, hardwoods have been used for intensive culture because of their early rapid growth and their ability to sprout from the stump after they are harvested, thus eliminating the need to replant the trees.

First, the site must be prepared to eliminate other plants and to make it suitable for the operation of planting and cultural equipment. Seedlings or cuttings are planted with mechanical planting equipment at varied distances from a few centimeters to several meters in rows that are from one to several meters apart. The first growing season is critical to the survival of the small trees, and they must be kept free of weeds by cultivating, planting a cover crop between the rows, or applying an herbicide. Each growing season the trees are provided optimal amounts of nutrients and water by fertilizing and irrigating. Diseases and insect pests must be managed. After presumably 6 to 10 years, at a time when the trees reach financial maturitv and near-optimal biological growth, the trees will be harvested using specially-desinged harvesters. The wood will be chipped and used for energy, chemicals, pulp, reconstituted wood products, feed, or any combination of these products. In the spring following harvest, with most species being considered for energy purposes, one or more new stems will sprout from the cut stumps, and these will become the next rotation of intensive culture trees.

10650 (SERI/TP—33-285, pp 375-379) **Energy and chemicals from woody species in Florida.** Smith, W.H.; Conde, L.F. (Univ. of Florida, Gainesville). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The project is attempting to assess the potential of six native and exotic woody species in Florida for the sustained production of fuel and chemicals as alternative sources to fossil fuels and petrochemicals. Included in this assessment will be evaluations of the amount of land available for production, effects on production of various cultural options, potential site effects of biomass-farming on water use and nutrient conservation, and energy input/output efficiencies. Test plantings for each species will be installed this year. Preliminary findings indicate that commercial: private ownership ratios vary from 1:3 in northern Florida to 3:1 in southern Florida. Superior selections of sand pine, slash pine, and Eucalyptus have been made from numerous existing progeny tests. Selections of promising trees of Melaleuca and Casuarina have been made from natural stands in south Florida. Wood and foliage heat values are each relativelty uniform across species but bark heat value is quite species dependent. Mean annual increment of aboveground dry biomass of trees in existing stands ranges rom 2,7 to about 7 tons/acre/year.

10651 (SERI/TP—33-285, pp 381-386) **Non-commercial woody plants as potential biomass fuel producers: an ecological rationale for their selection.** Ragsdale, H.L.; Skeen, J.N. (Emory Univ., Atlanta, GA). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

It appears likely that large-scale biomass energy plantations as presently envisioned (i.e., efforts involving such commercially-important species as Populus, Pinus, Alnus, and Plantanus) could eventually prove cost-ineffective owing to the intensity of management required and the corresponding loss of highly productive lands to food crop orientation. A viable alternative to this dilemma is woody species selection program directed toward successional species, toward exotic and/or rapidly colonizing urban species, and toward species inhabiting extreme or unfavorable habitats. These species have become, over time, well-adapted to a wide variety of marginal soils and habitats. Such species, once selected according to well-defined ecological and physiological criteria and evaluated for growth and biomass fuel species characteristics by comparative field trials at a common site, may then be outplanted to areas of marginal soils not presently under crop production. Such an approach has the obvious advantage of making a broader segment of the landscape usable while at the same time preserving our more productive agricultural lands for food crop porduction. The results of first-year efforts with such an approach in the southeastern US will be described. Twenty non-commercial species of particularly high potential and promise have been intensively screened and evaluated. The criteria utilized in selecting these highly promising species (e.g., physiological and environmental requirements, pollutant tolerances, weather/climatic constraints, disease resistance, growth form and propagation characteristics, biomass yields, etc.) will be presented. Data from preliminary germination, propagation, and culturing trials involving the more prominent species will be presented and their implications will be discussed.

10652 (SERI/TP—33-285, pp 387-392) **Species selection and silvicultural systems for producing fuels from woody biomass in the southeastern United States.** Fredrick, D.J.; Gardner, W.E.; Slichter, T.K.; Kellison, R.C.; Williford, M. (North Carolina State Univ., Raleigh). Oct 1979.

From 3. annual biomass energy systems conference; Golden, CO, USA (5 Jun 1979).

The Hardwood Research Cooperative in the School of Forest Resources at North Carolina State University is screening and evaluating woody species, and testing spacing and various silvicultural techniques for optimizing energy production. Analysis of 43 existing species-site tests installed by the Cooperative show loblolly pine to out produce most hardwoods. Several hardwoods can produce high yields but intensive cultural practices are required and planting must be done on specific soil types. Nine new species-site tests have been established during 1978-1979. A bottomland and an upland site using 8 species was planted in North Carolina to evaluate 3 spacings, fertilization and cultivation on growth, biomass and energy yields. Both of these sites are considered marginal for agriculture, the bottom!and site because of susceptibility to flooding and the upland site because ofnutrient deficiencies and past exploitation and erosion. They are representative of large acerages in the Southeast, and could represent the first sites available for energy plantations.

TRACER TECHNIQUES

10653 (COO—1358-16) **Biological transfer and loss of ^{36}Cl-labeled DDT in an old-field ecosystem.** Peterle, T.J. (Ohio State Univ., Columbus (USA). Dept. of Zoology). 20 Apr 1979. Contract EY-76-S-02-1358. 132p. Dep. NTIS, PC A07/MF A01.

An enclosed 10-acre old-field plot treated in June 1969, with chlorine-36 labeled DDT was sampled each year from 1969 through 1974 to monitor the fate of the insecticide in the soil and biota. In order to provide data on compartmentalization of DDT in the vegetation, invertebrates and vertebrates inhabiting the plot, sampling was carried out to estimate both body burdens of DDT and biomass of populations. Another aspect of this study, the determination of rates of accumulation of residues by invertebrates and vertebrates, has been reported previously (Forsyth and Peterle 1973; Forsyth et al. 1975; Peterle 1975). This report describes (a) temporal patterns of DDT residues in soil and biota from 1969 through 1974 and (b) quantities of DDT held in the soil and biotic compartments of the ecosystem. Part II of the report is concerned with translocation and accumulation of ^{14}C-DDT.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS

10654 (LA—8023-PR) **Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.** Petersen, D.F.; Sullivan, E.M. (comps.). (Los Alamos Scientific Lab., NM (USA)). Sep 1979. Contract W-7405-ENG-36. 192p. Dep. NTIS, PC A09/MF A01.

The research and development activities at LASL's Biomedical and Environmental Research Program is summarized. Reports relate the current status of the projects. The following groups are included: the mammalian biology group, the industrial hygiene group, the cellular and molecular biology group, the biophysics group, the organic and biochemical synthesis group, and the environmental sciences group.

IN VITRO

REFER ALSO TO CITATION(S) 10655

IN ANIMALS

REFER ALSO TO CITATION(S) 10656

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

REFER ALSO TO CITATION(S) 10604, 10666

10655 (CONF-790162—1) **Oxygen effects in radiation biology and radiation chemistry.** Powers, E.L.; Held, K.D. (Texas Univ., Austin (USA). Lab. of Radiation Biology). 1979. Contract EY-76-S-05-3408. 16p. Dep. NTIS, PC A02/MF A01.

From Association of Radiation Research conference; Wrexham, Clwyd, UK (3 Jan 1979).

The question of the influence of O_2 on the radiation sensitivity of organisms, cells and biomolecules is reviewed. Evidence is presented to show that there are two mechanisms that govern the manner in which O_2 acts in cells. It is also suggested that these may in addition be other mechanisms but no evidence is presented to support this. (ACR)

10656 (CONF-790524—12) **Combined genetic effects of chemicals and radiation.** Kada, T.; Inoue, T.; Yokoiyama, A.; Russel, L.B.

(National Inst. of Genetics, Mishima, Shizuoka (Japan); Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

From 6. international congress symposium on radiation research and stem cells; Tokyo, Japan (13 May 1979).

Interactions of chemicals and radiation are complex and there may exist other unexpected patterns that are not mentioned. We show some examples. Photodynamic mutation induction by fluorescein dyes and Radiosensitization with iodine compounds are classified as Interactions of chemicals and radiation outside of the cell. On the other hand, the Antimutagenic effects of cobaltous chloride is concerned with events taking place in cells that had already been exposed to a mutagenic agent. It is likely that the action of a mutagenic agent is not direct and that cellular functions, such as mutators or repair systems, are involved in the mutagenesis initiated by the agent. Such cellular functions can be affected by a second agent. In sexually reproducing organisms, the two agents can also act on separate cells (male and female germcells) which subsequently fuse. Interaction effects of all types will be useful in future research in shedding light on the main pathways of mutagenesis.

10657 (ORO—2832-202) **Radiation and biophysical studies on cells and viruses. Progress report, July 1, 1978-August 30, 1979.** Cole, A. (Texas Univ., Houston (USA). Dept. of Physics). 1 Oct 1979. Contract EY-76-S-05-2832. 11p. Dep. NTIS, PC A02/MF A01.

Ionizing radiation beams of low linear energy transfer (LET) and high LET (alpha particles) which penetrated part way into or completely through cell monolayers were used to study a variety of molecular and cellular responses including: DNA damage, chromosome aberrations, division delay, lethality, mutation, and transformation. Modifiers of radiation response such as oxygen tension, cell temperature, cell growth cycle stage, dose fractionation and/or post irradiation repair incubation were studied. The following properties were evaluated: cellular location of radiation susceptible sites, optimum action cross-sections, relative biological effectiveness (RBE) for high LET radiation, effect of radiation modifiers, and the kinetics of cell repair of the initial damage. Correlations among these properties suggested that similar genetic damage was involved in most responses. These and other data suggest that an important mode of genetic damage involves nuclear membrane associated DNA which suffers multiple proximate lesions induced by the high LET component of any form of ionizing radiation. Such damage may be assayed as a single or double strand DNA break but includes other DNA lesions in close proximity. Failure of the cell to properly repair such complex lesions may contribute to a variety of biological responses.

RADIATION EFFECTS ON MICROORGANISMS

10658 (ORO—3728-12) **Mutagenic effect of radionuclides incorporated into DNA of Drosophila melanogaster. Progress report, 1978-1979.** Lee, W.R. (Louisiana State Univ., Baton Rouge (USA). Dept. of Zoology and Physiology). 1979. Contract EY-76-S-05-3728. 13p. Dep. NTIS, PC A02/MF A01.

A significant difference in the mutation frequency of sex-linked recessive lethals was observed due to the position in the DNA molecule in which tritium decay occurred. This local effect of tritium decay is interpreted as being due to the transmutation of tritium to helium-3 at specific sites of tritium incorporation in DNA. The most mutagenic positions of disintegration appear to be the 8 of guanine (adenine) and the 6 of cytosine (thymine), i.e., those beta to the glycosidic bond. No significant increase in temperature sensitive sex-linked recessive lethals was found for tritium decay at the 5-position of cytosine over tritium decay at the other positions tested. Therefore, to determine the mechanism of mutation induction for the different sites of tritium decay, it will be necessary to study mutations induced at a specific locus with an identifiable protein.

FOOD PRESERVATION

10659 (AD-A—069968) **Cost of irradiating bacon and the associated energy savings. Technical report.** Brynjolfsson, A. (Army Natick Research and Development Command, MA (USA). Food Engineering Lab.). Mar 1979. 12p. NTIS PC A02/MF A01.

This paper is about costs and energy savings obtained by irradiating bacon. Sterilized by irradiation (25 kGy), bacon without added nitrite does not contain nitrosamines and does not constitute botulism hazard. If bacon is irradiation sterilized while refrigerated, the cost of irradiation is about $0.08/lb; if irradiation-sterilized while frozen, the costs of irradiation and freezing would be about $0.03/lb. Substerilizing irradiation doses of 7.5 to 15 kGy would give about 80 days extension of bacon stored and distributed refrigerated. The irradiation costs, in this case, would be about $0.07/lb.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 9730, 10671, 10686

10660 (AD-A—070239) **Analysis of radiation exposure for Task Force WARRIOR-Shot Smoky-Exercise Desert Rock, VII-VIII Operation Plumbbob. Final report, February 1978-February 1979.** Goetz, J.L.; Kaul, D.; Klemm, J.; McGahan, J.T. (Science Applications, Inc., McLean, VA (USA)). 31 May 1979. Contract DNA001-78-C-0186. 112p. NTIS PC A06/MF A01.

The radiation exposures to Task Force WARRIOR troops who participated in Shot Smoky are determined and compared with film badge data gathered during Exercise Desert Rock VII-VIII. Fallout contours and decay rates are established and used to calculate total exposure, based on estimated stay time for various troop activities. Uncertainties are calculated for each parameter. Exposures are corrected to a film badge equivalent environment to permit comparison with actual film badge readings. Total equivalent exposure is calculated to be 480 mrem as compared with a 575 mrem mean film badge reading for the entire operation.

10661 (NUREG/CP—0001, pp 184-198) **Biological effects of low levels of radiation exposure.** Casarett, G.W. (Univ. of Rochester, NY). Aug 1978.

In Radioactivity in consumer products.

Radiation exposure from consumer products and the biological effects of low levels of radiation are discussed. Also presented are radiation protection criteria and population dose equivalent limits. In the section of the paper dealing with pertinent radiobiologic principles the relationships of dose threshold and dose-effect are discussed as well as the relationships of linear energy transfer, relative biological effectiveness, quality factor and dose-effect. Nontumorigenic somatic effects, spermatogenesis, ovogenesis, cataractogenesis, development after embryonic-fetal irradiation, genetic effects and cancerogenic effects are discussed relative to consideration of risks at low radiation levels. (RJC)

10662 (NUREG/CP—0001, pp 217-226) **Radiation dose to the respiratory tract due to inhalation of cigarette tobacco smoke.** Walsh, P.J. (Oak Ridge National Lab., TN). Aug 1978.

In Radioactivity in consumer products.

The radiation dose to the respiratory tract from ^{210}Pb and ^{210}Po due to inhalation of cigarette tobacco smoke is discussed. Intake and clearance values for ^{210}Pb and ^{210}Po in smokers are given and the possible influence of the normal intake of radon daughters on these values is presented. Dose calculations as well as a table of alpha surface activities for various equilibrium conditions and free ^{218}Po fractions are included. The author also discusses the uncertainties associated with this area of study and the research needs. (RJC)

VERTEBRATES

REFER ALSO TO CITATION(S) 10603, 10640, 10656

10663 (EUR—6064(Vol.2), pp 937-947) **Molecular ion experiment.** Rossi, H.H.; Bird, R.; Colvett, R.D.; Kellerer, A.M.; Lam, Y.M.P. (Columbia Univ., New York (USA). Radiological Research Lab.); Rohrig, N. (Brookhaven National Lab., Upton, NY (USA)). 1978.

From 6. symposium on microdosimetry; Brussels, Belgium (May 1978).

In early simplifications of the Theory of Dual Radiation Action it was assumed that ionizing radiations produce lesions which arise from the combination of pairs of sublesions that are produced in 'sites', i.e. limited regions in the cell nucleus in which this combination can take place. In a more realistic treatment, the probability of combination depends on the separations at which the sublesions can be produced and the probability that combination occurs if such initial separations intervene. The molecular ion experiment is designed to determine this dependence. Pairs of ions with varying mean spacing are generated by the break-up of molecular ions and subsequent divergence by multiple coulomb scattering in a foil. The emergent ions traverse mammalian cells attached to the exit side of the foil. The principles of the experimental techniques are discussed and some initial results are presented.

10664 (LA—8023-PR, pp 3-7) **External radiation.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

The late biological effects of whole-body exposure to ionizing radiations from external sources, expressed in terms of life shortening, have been studied extensively. Variables such as total dose, dose rate, age of experimental subjects at the time of exposure, and genetic background are some of the characteristics that have been investigated separately and to a very limited extent with two of the above characteristics studied in combination. A single investigation,

which included all of the above listed variables, studied simultaneously in one environment by a single investigator, was performed to obtain unique and reliable data to assess properly the possible impact of external exposure to ionizing radiation on a mammalian population.

10665 (LA—8023-PR, pp 8-20) **Tumorigenesis in the lung.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Divisicn. Progress report, January-December 1978.

The original objectives of this program are the study of the comparative tumorigenicity of localized vs diffuse alpha irradiation in the hamster using large ceramic microspheres of ZrO_2 lodged in the lung capillary bed. The continuing program will be based on the methods and results already achieved, but a shift has occurred from a study of the effects of nonuniform dose distribution to a consideration of other basic factors affecting tumorigenesis. The starting points are two important discoveries made in the course of the previous investigations: (a) the observation by D.M. Smith that the tumor yield from alpha microspheres was greatly enhanced by the intratracheal (IT) administration of Fe_2O_3 suspended in saline, and (b) the demonstration by R.G. Thomas that inhalation of polydispersed aerosols of PuO_2 to ZrO_2 were extremely tumorigenic - in striking contrast to the ineffectiveness of either ZrO_2 or PuO_2 alone in comparable exposures. Both observations have potentially serious implications for the tumorigenicity of alpha particulates. The first suggests that the hazard may depend strongly on other concomitant lung insults, even apparently innocuous ones, while the second raises the possibility that the chemical nature of the matrix material carrying the alpha activity can have an equally profound effect. In this connection, it is important that ZrO_2 is chemically homologous with ThO_2 and UO_2 (fuel materials used in advanced power reactor design) and is used itself as a cladding material.

10666 (LA—8023-PR, pp 122-134) **Radiobiology studies.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Several ongoing research programs in radiobiology are summarized. An acute skin response in mice after exposure to single and fractionated doses of negative pions was compared to 300 kVP x rays. Residual radiation damage in the mouse foot after exposure to heavy particles is discussed. The effects of argon ions on synchronized Chinese hamster cells are discussed and survival curves are included. Cytokinetics and cell-survival response of multicellular spheroids to single vs fractionated x irradiation are studied. Flow cytometric analysis of spontaneous dog tumors was performed. (DC)

10667 **Functional aspects of blood platelets in irradiated burros.** Schneider, M.D. (Comparative Animal Research Lab., Oak Ridge, TN). Contract E-40-1-GEN-242. *Am. J. Vet. Res.;* **38**: No. 2, 209-216(Feb 1977).

In irradiated burros (Equus asinus), a delayed clinical syndrome characterized by a depletion of megakarocytes and platelets has been observed. To clarify the cause of this syndrome, the functional abilities of platelets in 7 irradiated and 3 control burros were studied in vitro. The irradiated burros were survivors (> 18 years) of total-body exposures to near-lethal doses of γ-radiation. Burro platelet aggregability induced with adenosine diphosphate and thrombin, and with a complex stimulator from burro aortas, was determined by means of a self-calibrating aggregometer. Data indicated that the aggregation responsiveness to adenosine diphosphate and thrombin of platelets from surviving irradiated and unirradiated burros is not defective. An extractible collagen-like stimulator of platelet aggregation was discovered in the aorta of a burro that had survived > 24 years after exposure to a total-body dose of 545 roentgens (R) of tantalum-182 γ-radiation. The platelet-aggregating ability of this stimulator from the vessel wall of the irradiated burro was nearly fourfold greater than that from the aorta of an unirradiated control. Perhaps a delayed radiation effect could be the cause of this vascular agent's high platelet-aggregating ability and could lead to a clinical syndrome marked by depletion of megakaryocytes and platelets.

10668 **Radiation-induced α-thalassemia in mice.** Popp, R.A.; Enlow, M.K. (Oak Ridge National Lab., TN). *Am. J. Vet. Res.;* **38**: No. 5, 569-572(1977).

The clinical hematologic change in 2 groups of progeny from mice carrying radiation-induced strain SEC α-chain deficiencies was found to be similar to the hematologic alterations in persons with α-thalassemia. The heterozygous deletion or inactivation of the α-chain gene in mice caused an anemia similar to α-thalassemina minor in persons. The α-chain deficiency in mice created an erythrocytosis, reticulocytosis, and microcytic, hypochromic anemia comparable with the changes in human α-thalassemia minor resulting from deletion of the α-chain gene. These mouse mutants are the only known animal models of human thalassemia. A comparison of hematologic values obtained from progeny possessing an α-chain gene deficiency and from progeny possessing a β-chain duplication suggested that the deficiency of α-chain synthesis, rather than a simple imbalance between the amounts of α- and β-chains produced, was primarily responsible for the altered hematologic characteristics in these α-thalassemic mice.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 10576

10669 (CONF-791077—4) **Distribution of ^{241}Am in the human body as determined by external counting.** Toohey, R.E. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 35p. Dep. NTIS, PC A03/MF A01.

From Workshop on measurement and interpretation of actinide accumulation by man; Snowbird, UT, USA (14 Oct 1979).

Methods for determining the distribution of ^{241}Am within the body of a contaminated subject and their application to several cases under study at the Center for Human Radiobiology are described. In general, ^{241}Am is found in the lungs even at long times after inhalation, and systemic ^{241}Am is observed to deposit in the liver and to label the skeleton in a fairly uniform manner; similar findings have been reported in animal studies (L172). Further analysis of the skeletal distribution of ^{241}Am indicates deposition on bone surfaces. In contrast, the distribution of injected ^{239}Pu in an (abnormal) skeleton is rather non-uniform when compared to that of ^{241}Am.

10670 (DP—1526, pp 51-55) **Dose calculations for the regional, continental, and global populations from a hypothetical nuclear fuel reprocessing plant located in the southeast United States.** Schubert, J.F.; Cooper, R.E.; Watts, J.R.; Bailey, C.E. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The population dose commitments that would result from operation of a hypothetical fuel reprocessing plant processing 3000 MTU/y and located in the southeast US were determined. The 50-y (40-y plant life plus 10 y after shutdown) dose commitments are 42,030 man-rem to the regional population, 135,400 man-rem to the continental population, and 220,300 man-rem to the global population. The dose commitments are significantly less than the population doses from nautral background radiation. The dose commitments from plant operations are 0.2% of regional, 0.01% of continental, and 0.001% of global doses from natural background radiation. Tritium, ^{14}C, and ^{85}Kr dominate the total population dose commitment, but their relative importance varies with pathways and the particular population being considered.

10671 (LA—8023-PR, pp 43-54) **Determination of plutonium in man.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

Several ongoing research programs which deal with plutonium levels in man are summarized. The following are the topics of research: plutonium in the tissues of the general population, analysis of tissues from occupationally exposed workers, cooperation with the National Bureau of Standards for the preparation of a natural matrix tissue standard, analysis of tissues from an individual exposed during operation "Big Bang" ("Smokey"), medical surveillance of 26 early Los Alamos plutonium workers, epidemiologic studies of persons exposed to plutonium, limits for the burial of the Department of Energy transuranic wastes, and a preliminary study of radium contaminated soils.

ANIMALS

10672 (PNL—3089) **Dosimetry of inhaled plutonium-239 dioxide in rodent lung: a morphometric study.** Rhoads, K. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Jun 1979. Contract EY-76-C-06-1830. 124p. Dep. NTIS, PC A06/MF A01.

Morphometric analysis of rat and hamster lung did not demonstrate any extensive changes in lung composition or structure following inhalation exposure to $^{239}PuO_2$ at levels near that for maximum tumor yield in rats. The problem of dosimetry for this compound thus appears to be relatively uncomplicated by any major radiation-induced pathological alterations in the lung. Rat and hamster lung were found to be similar in structure and composition, with few significant differences which could be directly related to the different tumor responses. The distribution of $^{239}PuO_2$ particles was not uniform in all regions of the lung; thus estimation of the dose to specific tissues or regions within the lung requires a correction for this effect. Species differences were found for particle distribution in the subpleural region and major airways, and in the spatial association of particles, both of which may affect the tumor development process. These regions contain the principal target cells for tumor production and serve as foci for the origin of tumors. Different dose distributions within these regions may therefore explain, at least in

part, the difference in tumor response to inhaled $^{239}PuO_2$ for rats and hamsters.

PLANTS

REFER ALSO TO CITATION(S) 10578

THERMAL EFFECTS

MICROORGANISMS

REFER ALSO TO CITATION(S) 10538

10673 (DP—1526, pp 135-137) **Effect of reactor operations on the productivity of the algal-bacterial mat community in the p-canal cooling system.** Tison, D.L. (Rensselaer Polytechnic Inst., Troy, NY); Pope, D.H.; Wilde, E.W.; Fliermans, C.B. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Algal community structure and activity were studied from 55° to 40°C along a thermal gradient, and at ambient temperatures during a reactor down period. The community structure and percent-dissolved organic matter data suggest that algal populations may respond to thermal stress by increasing the amount of photosynthetically fixed CO_2 released as dissolved organic matter.

10674 (DP—1526, pp 139-142) **Mineralization of degraded substrate as an indicator of thermal stress in heterotrophic bacteria.** Tison, D.L.; Pope, D.H.; Fliermans, C.B. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Organisms growing in the thermally altered cooling water of a Savannah River Plant nuclear production reactor are exposed to large temperature fluctuations due to reactor operations. Data from experiments on algal-bacterial mat communities, indicate that the percentage of substrate mineralized increases when the heterotrophs are at temperatures other than their adapted temperatures.

10675 (DP—1526, pp 143-146) **Community development in a thermal gradient microcosm.** Tison, D.L. (Rensselaer Polytechnic Inst., Troy, NY); Pope, D.H.; Fliermans, C.B. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The thermal gradients created by the thermally altered cooling water from Savannah River Plant nuclear production reactors provide a unique situation for studying de novo development of thermophilic microbial communities. A lotic microcosm as described previously (See Tison, p.135) allowed for development of microbial communities affected only by thermal conditions. Autotropic and heterotrophic structure and function during development of microbial communities at 60°, 55°, 50°, and 45°C are described. No photoautotrophic uptake of $^{14}CO_2$ occurred at 60°C. Maximum primary productivity occurred at 55°C. Bacterial populations and primary productivity values were closely related at the temperatures of this study.

10676 (DP—1526, pp 159-162) **Upper temperature limits for algae in SRP reactor effluents.** Wilde, E.W. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

Thermal effluents from the Savannah River Plant nuclear reactors provide an opportunity to study responses of algae to a severe temperature stress. Summer temperatures in reactor discharge canals often range from > 75°C, which is higher than the maximum tolerable temperature for all known algae, to near ambient. Algal communities above 56 to 60°C consist only of 2 blue-green alga taxa. The communities become increasingly more complex as the water cools; at near ambient, 40 species (6 blue-greens, 15 greens, and 19 diatoms) were observed.

10677 (DP—1526, pp 163-166) **Seasonal response of periphyton to temperature elevation.** Brown, D.C. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The Flowing Streams Laboratory consists of streams maintained at temperatures of 2.5, 5, 7.5, and 12.5°C above ambient. The taxonomic composition of algal communities from elevated temperature streams differs from that of the ambient temperature streams. Algal biomass (as measured by chlorophyll a per slide) and productivity (as measured by ^{14}C-uptake per slide per h were measured in ambient temperature, +5°C, and +12.5°C streams for 1 y. The communities in the 3 streams differed significantly. The elevated temperature changed the seasonal pattern of biomass and productivity of the periphyton.

10678 (DP—1526, pp 167-169) **Effect of temperature elevation on periphyton communities from enriched and unenriched streams.** Brown, D.C. Nov 1979.

In Savannah River Laboratory environmental transport and effects research. Annual report, 1978.

The interactions of elevated temperature and nutrient addition can affect both the species' composition and the productivity of algal communities in patterns which differ from single-factor effects. Periphyton communities from Upper Three Runs Creek were used to investigate this interaction at the Flowing Streams Lab. The hypothesis was that unenriched (oligotrophic) and enriched (simulated eutrophic) periphyton communities would differ in biomass and rate of primary productivity under different temperature regimes. In general, the experiments indicated that increased nutrient concentration stimulated periphyton growth and production in July with the +12°C community, and in January with the ambient temperature community.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 9652

10679 (EML—363, pp I.3-I.30) **Release of trace substances by a coal fired power station into an aquatic ecosystem. 1. Environmental sampling in Cayuga Lake, NY.** Heit, M.; Klusek, C.S. 1 Oct 1979.

In Environmental Measurements Laboratory environmental quarterly, June 1-September 1, 1979.

Sediment, water, plankton, macrophyte and fish sampling in Cayuga Lake, NY, is described as part of a program aimed at studying the fate of trace elements, organics, and radionuclides released from a coal-fired electric generating station into an aquatic ecosystem. The use of fresh water mussels as biological monitors of the incorporation of trace substances into the food web is also discussed. Experiments with mussel species collected in Lake George, NY, showed that these organisms concentrated Cd, Cu, Hg, Se, and Zn in their soft tissues above levels measured in the sediment in which they were captured. Chromium, Pb, and Ni occurred at sedimentary concentrations in the tissues, while Sn and As were found at only a percentage of their sedimentary concentrations and may therefore be actively eliminated by these organisms. One mussel species, Elliptio complanatus, was found to be more tolerant of higher water temperature than the other species examined Lampsilus radiata and Anodonata grandis.

CELLS

REFER ALSO TO CITATION(S) 10604, 10656

10680 **Transformation of tracheal epithelium exposed in vitro to N-methyl-N'-nitro-N-nitrosoguanidine (MNNG).** Steele, V.E.; Marchok, A.C.; Nettesheim, P. (Oak Ridge National Lab., TN). *Int. J. Cancer;* No. 20, 234-238(1977).

Using an organ culture/cell culture system, we transformed rat tracheal epithelial cells in vitro by exposure to MNNG. Ten tracheal organ cultures per group were exposed twice (at days 3 and 6) to 0, 0.001, 1.0 or 10.0 μg MNNG/ml of medium. Following this exposure, the explants were placed on the bottom of culture dishes to initiate epithelial cell outgrowths and establish primary cultures. Each explant was replanted 8 to 10 times to produce multiple outgrowths. The number of primary cultures and the number of subsequently established cell lines obtained was carcinogen-dose-dependent. The average number of primary epithelial cell cultures per explant after exposure to 0, 0.001, 1.0 and 10.0 μg MNNG/ml was 1.3, 1.5, 3.3, and 4.6, respectively. The average yield of cell lines per explant in these groups was 0, 0.8, 1.3, and 2.0, respectively. It is apparent that cell lines could only be established from carcinogen-exposed epithelium. These cell lines are currently being tested for tumorigenicity in vivo. To date, of 35 cell lines tested between the 5th and 15th passages, 5 cell lines from the 10 μg MNNG/ml group and 2 from the 1.0 μg MNNG/ml group have produced palpable tumors upon injection into immunosuppressed recipients.

MICROORGANISMS

REFER ALSO TO CITATION(S) 10590

PLANTS

10681 (BNL—26971) **Effects of simulated acid rain on growth and yield of soybeans and pinto beans.** Evans, L.S.; Lewin, K.F. (Manhattan Coll., New York (USA). Lab. for Plant Morphogenesis; Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 24p. (CONF-791090—3). Dep. NTIS, PC A02/MF A01.

From Symposium on potential environmental and health effects of atmospheric sulfur deposition; Gatlinburg, TN, USA (14 Oct 1979).

In order to assess the degree of damage that acid rain has or might have on plants, experiments were performed to determine the change in seed yield of two agronomic crops, soybeans and pinto beans, after exposure to simulated rain of pH 5.7, 3.1, 2.9, 2.7, and 2.5. Moreover, the effects of simulated acid rain were determined on a variety of other experimental parameters to understand further how plants respond to this environmental stress. Simulated acid rain of pH 3.1 and below decreased the dry mass of seeds, leaves, and stems of pinto beans. On a percentage mass basis the decrease in seed yield was comparable to reductions in biomass of leaves and stems. The decrease in yield of pinto beans by simulated acid rain was attributed to both a (1) decrease in the number of pods per plant and (2) a decrease in the number of seeds per pod. In soybeans, simulated acid rain decreased the dry mass of both stems and leaves. Seed yield also decreased after treatment with rain of pH 2.5. However an increase in seed yield occurred when plants were exposed to rain of pH 3.1. A larger dry mass per seed was responsible for the larger dry mass of seed per plant.

10682 (UCLA—12-1218) **Trace element stress in plants: effects and methodology.** Berry, W.L.; Wallace, A. (eds.). (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). 1979. Contract EY-76-C-03-0012. 78p. (CONF-791145—(Absts.)). Dep. NTIS, PC A05/MF A01.

From International symposium on trace elements stress in plants; Los Angeles, CA, USA (6 Nov 1979).

Although energy technology is a theme which involves many aspects of trace elements, any evaluation of environmental effects must recognize that there are many sources of trace elements in the environment. This symposium considers the effects of the total trace element component of the environment on plants, rather than those from individual sources. The goal is a comprehensive survey of the effects of trace elements on plants which, because of the basic position plants hold, has implications for all food chains. This program highlights the physiological aspects of trace element effects in plants.

INVERTEBRATES

REFER ALSO TO CITATION(S) 10590

VERTEBRATES

REFER ALSO TO CITATION(S) 9681, 10016, 10603, 10680

10683 (LA—8023-PR, pp 32-34) **Toxicity of insulating materials.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

A study of the toxicity that may be associated with the manufacture and use of various fibrous materials was begun in the summer of 1978. This work will be centered around inhalation toxicity studies accompanied by short-term screening of materials in the manner described elsewhere in this report under Applied Toxicology. This project was entered into with the Industrial Hygiene Group (H-5) and is funded by the Thermal Insulation Manufacturers Association. The expertise that has been associated with various aspects of the toxicity studies carried on in Group H-4 will be applicable to this new endeavor. Some pilot work has been started, but is of a preliminary nature, and reporting will not be attempted at this time. The revamping of inhalation chambers to allow nose-only exposure to aerosols of fibrous materials has been accomplished, as reported below. The Aerosol Physics Section of Group H-5 is developing the aerosols to be used in the rodent exposures, and pilot studies have been initiated.

10684 (LA—8023-PR, pp 34-36) **Applied toxicology.** Sep 1979.

In Biomedical and Environmental Research Program of the LASL Health Division. Progress report, January-December 1978.

The toxicity of a variety of mixtures used for industrial purposes was studied. The acute effects of these materials were examined in vivo and the possible mutagenic effects were studied in vitro. The general screening procedures were delineated. A status report on the following materials was tabulated: (1) sylgard 184, (2) silastic 386 catalyst, (3) silastic 386 foam elastomer, (4) silastic 386 foam elastomer:catalyst, (5) dimerized phenyl propargyl ether, (6) 5% palladium on alumina, and (7) hydrogen getter.

10685 **Proliferation of lung and airway cells induced by nitrogen dioxide.** Hackett, N.A. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). Contract EY-76-C-04-1013. *J. Toxicol. Environ. Health;* **5**: No. 5, 917-928(Sep 1979).

Proliferation of lung cells of Chinese hamsters was examined in several regions of the lung parenchyma and ciliated airway epithelium after a 24-h exposure to 28.2 mg/m^3 (15 ppM) nitrogen dioxide (NO_2). Label was retained 3 wk after the injection of [^{3}H]thymidine, and autoradiographic methods were used to localize the site of retention. By 24 h after administration of [^{3}H]thymidine, parenchymal areas, exclusive of airways, showed an increased labeling index, indicative of cell death and replacement. This increase in the number of labeled cells persisted for 3 wk. Type II cells were labeled twice as frequently in regions of the terminal bronchiole than in other alveolar areas. Type II cell cycle time was reduced from 26 to 3 d after NO_2 exposure. Alveolar macrophages were significantly labeled in the alveolar areas during the thymidine pulse at the end of the exposure episode and retained label for 3 wk. Airway epithelia showed no labeling in the trachea and progressively greater labeling in increasingly smaller airways. Epithelial cells lining the small airways and alveoli showed greater susceptibility to NO_2 injury than cells lining the bronchi or trachea. Nonciliated or basal cells serve as a precursor of ciliated cells in the epithelium of small airways (0.35 mm) and bronchi.

MAN

REFER ALSO TO CITATION(S) 9682

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 10525, 10607

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 10574

10686 (NUREG/CP—0001) **Radioactivity in consumer products.** Moghissi, A.A.; Paras, P.; Carter, M.W.; Barker, R.F. (eds.). (Nuclear Regulatory Commission, Washington, DC (USA)). Aug 1978. 517p. NTIS, PC A22/MF A01.

Papers presented at the conference dealt with regulations and standards; general and biological risks; radioluminous materials; mining, agricultural, and construction materials containing radioactivity; and various products containing radioactive sources.

10687 (NUREG/CP—0001, pp 227-240) **Naturally occurring radioactivity in ophthalmic glass.** Goldman, M. (Univ. of California, Davis); Yaniv, S.S. Aug 1978.

In Radioactivity in consumer products.

The manufacture of ophthalmic glass frequently utilizes mixtures of rare earths and zirconium oxides, which contain low levels of alpha-emitting decay products of natural thorium and uranium. Because of a concern about the possible effects of alpha irradiation of the cornea of the eye, the US Atomic Energy Commission in 1974 conducted a survey to determine the nature and quantity of radioactivity that might be present in ophthalmic glass in the United states and reviewed the pertinent dosimetry and radiobiologic significance related to the use of such glass. This report summarizes the salient features of the dosimetry used, briefly discusses the pertinent radiobiology, presents the results of analyses of 441 glass samples, and describes the industry ophthalmic glass radiological standard, issued voluntarily by the industry on November 1, 1975. (RJC)

10688 (NUREG/CP—0001, pp 241-252) **Assessment of radiation doses from radioactive materials in consumer products - methods, problems, and results.** O'Donnell, F.R. (Oak Ridge National Lab., TN). Aug 1978.

In Radioactivity in consumer products.

Assessments of radiation doses from spark-gap irradiators, personnel neutron dosimeters, slightly contaminated scrap iron and incandescent mantles are summarized. Assessment techniques and methodology are described briefly and some assessment problems discussed. Specific topics of concern in assessments of radiation doses to man from consumer products include an accurate and complete definition of the source term; knowledge of the state of the radionuclides present (i.e., abundance and physical and chemical behavior); and accurate definition of potentially important exposure pathways, preferably based on empirical data. (RJC)

10689 (NUREG/CP—0001, pp 332-343) **Radioactivity in building materials.** Harley, J.H. (Energy Research and Development Administration, New York, NY). Aug 1978.

In Radioactivity in consumer products.

This paper is intended as a general review of indoor exposures both to external gamma radiation and to inhalation of the short-lived daughter products of radon. Where possible, these will be related to the radioactivity in the building materials themselves. The author has had the tremendous advantge of reviewing the draft

material on this subject that will be included in the 1977 UNSCEAR report. This has helped considerably in evaluating the available data and in selecting the considerations to be emphasized.

10690 (NUREG/CP—0001, pp 423-433) **Evaluation of polonium-210 static eliminators.** Niemeyer, R.G.; Case, F.N.; Cutshall, N.H. (Oak Ridge National Lab., TN). Aug 1978.

In Radioactivity in consumer products.

Static elimination devices using alpha particles emitted from polonium-210 are manufactured and sold to the general public. These devices are used to remove dust from phonograph records, photographic negatives and slides, lenses, etc. Each static elimination device nominally contains about 500 μCi of polonium-210 at the time of manufacture. This paper discusses the results found when twenty-two such devices were subjected to a variety of tests to determine their potential release of radioactive material under conditions of normal use and during minor accidents and fires. (RJC)

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 9714, 9715, 10557, 10558, 10559

10691 (DP-MS—79-46) **Determination of the location and connectivity of fractures in metamorphic rock with in-hole tracers.** Marine, I.W. (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1979. Contract EY-76-C-09-0001. 35p. (CONF-7910120—1). Dep. NTIS, PC A03/MF A01.

From Annual meeting of the Geological Society of America; San Diego, CA, USA (20 Oct 1979).

In-hole tracer tests were used in a geohydrologic investigation of metamorphic rock at the Savannah River Plant near Aiken, SC to locate water-transmitting fractures and to determine the connectivity of these fractures between boreholes. Only after development of a conceptual model of the fracture occurrence and connection could the proper methods of analysis for the hydraulic parameters be selected. In-hole tracers were used to locate fractures in a borehole and supplemented other methods, such as core inspection, geophysical logs, borehole wall imaging techniques, dry drilling, and packer tests. The first three of these do not necessarily investigate fluid-transmitting fractures. In the study of the connectivity of fractures between boreholes, the in-hole tracer techniques supplemented determinations by the rapidity of hydraulic response and the use of between-well tracer tests. In hydraulically transmissive rock, fractures were located by changes in the velocity of the tracer pulse in response to adding fluid to the well. In virtually impermeable rock, the movement of the tracer pulse in the rock was normalized to the movement of another tracer pulse in the cased portion of the well because the movement was so slow that direct measurement was difficult. Connectivity of fractures between boreholes was determined by placing an in-hole tracer in one hole and measuring the movement induced by pumping a nearby borehole. From this test, it was determined that the fractures were interlacing, and single fractures did not extend from one borehole directly to the other.

10692 (KBS-TR—47, pp 1-61) **Groundwater flow due to topographical and geological effects.** Stokes, J. (Tekniska Hoegskolan, Stockholm (Sweden)). May 1978.

In Investigations of groundwater flow in rock around repositories for nuclear waste.

A first investigation of the principal aspects of groundwater flow when varying topography, hydraulic conductivity and geometry is presented. The groundwater table was assumed coincident with topography. The conductivity was assumed constant or exponentially decreasing with depth. The bottom was either fixed or infinite. Numerical examples containing equipotentials, streamlines, lines of equal flux and travel times are presented. Several profiles in the Forsmark area were analysed to show the effects of regional flow.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 10051, 10057, 10072, 10073, 10074, 10075, 10076, 10077, 10078, 10079, 10095, 10096, 10098, 10099, 10107, 10108, 10109, 10110, 10111, 10112, 10113, 10114, 10115, 10116, 10117, 10118, 10119, 10120, 10121, 10122, 10123, 10124, 10147, 10157, 10158, 10159, 10160, 10161, 10162, 10163, 10164, 10165, 10166, 10167, 10168, 10169, 10170, 10171, 10172, 10173, 10389

10693 (AD-A—070015) **Research in seismology. Semi-annual technical report no. 1, 1 October 1978—31 March 1979.** Nuttli, O.W.; Mitchell, B.J. (Saint Louis Univ., MO (USA). Dept. of Earth and Atmospheric Sciences). 23 Apr 1979. Contract F49620-79-C-0025,. 85p. NTIS PC A05/MF A01.

The contents are as follows: Excitation and Attenuation of Short-Period Crustal Phases in Southern Asia; Determination of Q models from Surface Wave Spectra; Source Studies of Some Eurasian Earthquakes; Frequency Dependence of Q sub beta in the Continental Crust; Higher-mode Attenuation in the Middle East.

10694 (LBL—10139) **Statistical analysis of the correlation of earthquakes with radon concentration in water from shallow wells near Oroville, California.** Berlin, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1979. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

This work is part of an investigation to determine whether a statistical relationship exists between varying radon concentration in well waters and the occurrence of nearby earthquakes. If such a dependence is verified, then certain patterns of changing radon activity may be useful for predicting earthquakes. Radon concentration in two water wells near Oroville, California, the Prosise and the Gilley wells, were compared with periodic aftershocks of the August 1, 1975, Oroville earthquake for a period of about 600 days. The data are consistent with data being generated from a distribution of either all noise; or long-term seismic fluctuations correlated with changes in the Prosise well, or short-term seismic fluctuations with changes in the Gilley well, or both. In both cases, the dependence must be expressed with different equations in different directions from the wells. Also, the data are inconsistent with data being generated from a distribution where the dependence between seismic activity and radon activity is very strong in all directions. 6 figures. (RWR)

10695 (PNL—2893) **Seismic data catalog and associated graphical capabilities.** Bishop, T.N.; Foote, H.P.; Blair, S.C. (Battelle Pacific Northwest Labs., Richland, WA (USA)). Nov 1979. Contract EY-76-C-06-1830. 55p. Dep. NTIS, PC A04/MF A01.

To facilitate the use of the enormous amount of earthquake data presently available, Pacific Northwest Laboratory (PNL) formed an extensive data base of compiled seismic data. PNL also developed many useful and unique computer techniques for analysis and display of the data. These techniques could be used in many areas of the United States to support nuclear waste management and other energy-related activities. Software associated with the data base includes programs for editing earthquake files; sorting files with respect to time, location, or magnitude; selecting data by use of various parameters; and merging files. These techniques allow the rapid formation of data files that are tailored to specific interests. The desired file may then be listed or displayed graphically by means of PNL's diversified graphic capability. From the data analysis software, an accurate and comprehensive earthquake catalog for the Pacific Northwest was created. This catalog was produced by merging data from many sources and includes microearthquake data. Duplicate events were eliminated, while all information available for a particular event was retained. Graphic displays can plot two- and three-dimensional epicenter or hypocenter information. Magnitude and/or depth information can be represented on two-dimensional plots by using color or symbol size. Plots can be produced using a variety of map projections and at a specified scale. This capability allows the use of any desired map as a base map for the display of earthquake data. Additional information such as rivers, coastlines, faults, and boundaries may also be included on the plots. Data may also be displayed using normal or two-dimensional histograms. 19 figures, 7 tables.

10696 **Extensive study on a simple method estimating response spectrum based on a simulated spectrum.** Sato, H.; Komazaki, M.; Ohori, M. (Tokyo Univ. (Japan). Inst. of Industrial Science). pp K4/9 1-11 of Structural mechanics in reactor technology. Jaeger, T.A.; Boley, B.A. (eds.). Amsterdam, Netherlands; North-Holland (1977).

From 4. international conference on structural mechanics in reactor technology; San Francisco, CA, USA (15 Aug 1977).

The response spectrum is significant in estimating the seismic coefficient in dynamic aseismic design. It was demonstrated in the previous work that the response spectrum for earthquake motions could be simulated by an artificial earthquake with two ground predominant periods. However, the simulation procedure took much time and it was practically impossible to assume more than two ground predominant periods for complexity of the computation. In order to overcome these difficulties a simple method estimating the response spectrum of building and building appendage structure was developed. The basic description of the procedure as follows will be briefly described in the paper. Corresponding to peaks of the response spectrum for the earthquake motion the component of the respective ground predominant period was taken. The acceleration amplification factor of a building structure for the respective predominant period above taken was obtained from the spectrum for the simulated earthquake with single predominant period. The rate

of the respective component in summing these smplification factors was given by satisfying the ratio among the magnitude of the peaks of the spectrum. The summation was made by the principle of the square root of sum of squares. The procedures was easily applied to estimate the spectrum of the building sppendage structure.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 9719, 9723

10697 (LA—8139-MS) **Mineralogy and petrology of tuff units from a UE25a-1 drill site, Yucca Mountain, Nevada.** Sykes, M.L.; Heiken, G.H.; Smyth, J.R. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 78p. Dep. NTIS, PC A05/MF A01.

Drill hole UE25a-1 has penetrated tuffs of Tertiary age which contain two major zeolitized horizons at depths below 380 m. These horizons are restricted to low-density, high-porosity nonwelded tuffs below the basal vitrophyre of the Topopah Springs Member of the Paintbrush Tuff (approximately 70 m above the current water table), and interfinger with more-densely-welded devitrified tuffs of granophyric mineralogy. Zeolites occur as glass pyroclast replacement, vug linings, and fracture fillings. Nonwelded units above the welded portion of the Topopah Springs Member are essentially unaltered, indicating that they have never been ground water-saturated for any significant length of time. Zeolite mineral assemblages appear to be characteristic of low temperature ($<100°C$) ground water alteration of glass in an open hydrologic system. The principal zeolite phase is high-Si clinoptilolite with Si/Al ratios of 4.7 to 6.0. Ca tends to be the dominant large-radius cation, but grains with dominant K or Na are not uncommon, particularly with increasing depth. Compositional variations in clinoptilolite may be due to ground water composition or original pyroclast composition. Minor amounts of mordenite, characterized by lower silica content (<55 wt %) and high alkali content (>10 wt % $Na_2O + K_2O$), occur as vug fillings at depths below 500 m. Presence of mordenite may indicate slightly elevated alteration temperatures, but more likely reflects enrichment of ground water in alkalis with depth. Mineralogical, compositional, and textural similarities of the zeolitized tuffs from UE25a-1 and J-13 are compatible with a single episode of crystallization. 16 figures.

10698 **Shearing of saturated clays in rock joints at high confining pressures.** Wang, C.; Mao, N. (Department of Geology and Geophysics, University of California, Berkeley, California 94720). *Geophys. Res. Lett.;* **6**: No. 11, 825-828(Nov 1979).

Saturated clays are sheared between rock joints at various pore water pressures and at confining pressures up to 3 kb (300 Mpa). Sliding on these joints is stable. For a given clay, the shear stress required to initiate sliding increases linearly with the effective normal stress across the sliding surface, with a slope of 0.08 +- 0.01 for joints filled with saturated montmorillonite, 0.12 +- 0.01 with saturated chlorite, 0.15 +- 0.01 with saturated kaolinite, and 0.22 +- 0.02 with saturated silty illite. Thus at high confining pressures the shear stress required to initiate sliding on joints filled with saturated clays are very much smaller than that required to initiate sliding on clean rock joints or on joints filled with dry gouge materials. In the crust, saturation of gouge materials along active faults would greatly lower the frictional resistance to faulting and would stabilize fault movement. Different fault behaviors such as stable creep along some faults and intermittent but sudden slip along others may reflect in part different degrees of saturation of fault zones at depth.

OCEANOGRAPHY

REFER ALSO TO CITATION(S) 10593

10699 **Sea surface temperatures near a bay inlet zone.** Powell, M.D.; Raman, S.S. (Atmospheric Sciences Division, Brookhaven National Laboratory, Upton, New York 11973). *J. Geophys. Res.;* **84**: No. C11, 7012-7016(20 Nov 1979).

Results of an investigation of the radiometric sea surface temperature distribution near Shinnecock Inlet off Long Island are presented. The data were gathered by 10 individual aircraft flights during summer of 1975. Inflow into or outflow from the inlet could be easily identified with sea surface temperature measurements.

10700 **Gulf stream boundary eddies off the east coast of Florida.** Vukovich, F.M.; Crissman, B.W.; Bushnell, M.; King, W.J. (Research Triangle Institute, Research Triangle Park, NC 27709). EF-77-C-05-5444. *J. Phys. Oceanogr.;* **9**: No. 6, 1214-1222(Nov 1979).

Satellite infrared data and in situ data were used to study eddies off the east coast of Florida. The surface thermal manifestation of the eddies identified in the infrared data were alternating cold and warm tongues, conforming to the cyclonic spin-off eddies observed by Lee (1975); however, the eddies identified in the satellite data were larger than those observed by Lee. Statistics derived from the satellite data indicated that the eddies had average major and minor axes of 136 and 36 km, res,pectively, assuming an elliptic shape. They moved northward at an average speed of 30 km day^{-1}, and the average period was 9 days.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

REFER ALSO TO CITATION(S) 10702

10701 **Southern hemisphere measurements of the anisotropy in the cosmic microwave background radiation.** Smoot, G.F.; Lubin, P.M. (Space Sciences Laboratory and Lawrence Berkeley Laboratory, University of California, Berkeley). *Astrophys. J., Lett. Ed.;* **234**: No. 2, L83-L86(1 Dec 1979).

A recent airborne measurement of the large—angular-scale anisotropy in the cosmic background radiation from the southern hemisphere (Lima, Peru) is in essential agreement with previous measurements from the northern hemisphere. The net anisotropy from the combined data can be described by a first-order spherical harmonic (Doppler) anisotropy of amplitude 3.1 +- 0.4 mK with a quadrupole component of less than 1 mK. Additional ground-based measurements of the linear polarization yield an upper limit of 1 mK, or one part in 3000, at 95% confidence level for the amplitudes of any spherical harmonic through third order.

STARS

REFER ALSO TO CITATION(S) 10864

10702 **Experimental neutrino astrophysics.** Lande, K. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). EY-76-C-02-3071. *Annu. Rev. Nucl. Sci.;* **29**: No. 1, 395-454(Dec 1979).

Past and future experiments involving the detection of cosmic neutrinos are reviewed. Production mechanisms, such as the gravitational collapse of massive stars, are discussed. (AIP)

10703 **Dysprosium III lines in the spectra of peculiar A and B stars.** Aikman, G.C.L.; Cowley, C.R.; Crosswhite, H.M. (Dominion Astrophysical Observatory, Herzberg Institute of Astrophysics). *Astrophys. J.;* **232**: No. 3, 812-818(15 Sep 1979).

We demonstrate that the Dy III line list from the laboratory study of Hussain represent pure Dy but in many stages of ionization; when known Dy I and Dy II lines are purged from this list, many of the remaining lines coincide with hitherto unidentified lines in the hotter Ap and Bp stars, notably for HR 465 at rare earth maximum. A search list of 34 relatively unblended lines of Dy III is proposed, and the Dy III spectrum is shown to be present in about 16 well-known chemically peculiar stars.

SOLAR PHENOMENA

10704 (COO—4634-T2) **Investigation of possible sun-weather relationships.** Businger, S. (Colorado Univ., Boulder (USA). Dept. of Astro-Geophysics; National Center for Atmospheric Research, Boulder, CO (USA)). 1978. Contract ER-78-S-02-4634. 82p. (NCAR/CT—49). Dep. NTIS, PC A05/MF A01.

Thesis.

Statistical correlations between anomalous solar activity (as denoted by large solar flares, active plages, and interplanetary magnetic sector boundaries) and the circulation of the troposphere are reviewed. Two indices (measuring atmospheric vorticity and mean zonal geostrophic flow in the northern hemisphere) are analyzed in an effort to reveal possible sun-weather relationships. The result of this analysis provides no additional statistical evidence for a connection between solar activity and the weather. Finally, physical mechanisms that have been suggested to explain the claimed correlations are discussed.

10705 **Observation of an impulsive solar X-ray burst from a coronal source.** Kane, S.R.; Anderson, K.A.; Evans, W.D.; Klebesadel, R.W.; Laros, J. (Space Sciences Laboratory, University of California, Berkeley). *Astrophys. J., Lett. Ed.;* **233**: No. 3, L151-L155(1 Nov 1979).

New observations of the spatial, spectral, and temporal structure of an impulsive hard X-ray source in a behine-the-limb solar flare have been made with high time resolution, hard X-ray detec-

tors aboard two spacecraft, the International Sun Earth Explorer 3 (ISEE 3) and the Pioneer Venus Orbiter (PVO), which were separated in heliographic longitude by ~12°.5. The principal findings are that (1) the coronal part of the X-ray source is ~600 times less intense than the lower-altitude part of the source; and (2) the coronal X-ray observations are consistent with a power-law electron spectrum which extends down to ~5 keV.

10706 Solar wind plasma processes and transport. Feldman, W.C. (University of California, Los Alamos Scientific Laboratory Los Alamos, New Mexico 87545). *Rev. Geophys. Space Phys.;* **17**: No. 4, 1743-1751(Oct 1979).

This is a review of major recent advances in the transport of solar wind plasma. Topics covered include interplanetary magnetic fluctuations, nonlinear solar wind ion equilibria, Debye wavelength electrostatic fluctuations, Type III interplanetary radio bursts, electron heat flux regulation and thin interplanetary current sheets.

GALAXIES

REFER ALSO TO CITATION(S) 10890

10707 Compatibility restrictions in the theory of antiresonance line shapes. Druger, S.D. (Department of Physics, Clarkson College of Technology, Potsdam, New York 13676). *J. Chem. Phys.;* **72**: No. 1, 639-649(1 Jan 1980).

The quasicontinuum correlation parameters that occur in the theory of antiresonance line shapes and radiationless decay, by virtue of being defined in terms of averages over the same set of quasicontinuum states, are shown to be restricted by conditions of mutual compatibility. These restrictions are analyzed in geometrical terms and some of their consequences are examined. A new correlation parameter λ is introduced and shown to qualitatively measure in many ways the overall consequences of correlations among the quasicontinuum couplings for many sparsely spaced states. A method is given for parametrizing the line shape and radiationless decay theory so as to satisfy the compatibility restrictions implicitly, thereby facilitating the analysis of experimental data. The application of the compatibility relations to the analysis of some recently reported line shape studies for molecules and solids is then discussed, including recent work on the optical absorption spectrum of boron-doped silicon.

COSMOLOGY

REFER ALSO TO CITATION(S) 10817

10708 (ORO—3992-370) **Primordial synthesis of anomalous nuclei.** Dicus, D.A.; Teplitz, V.L. (Texas Univ., Austin (USA). Center for Particle Theory). Sep 1979. Contract EY-76-S-05-3992. 14p. Dep. NTIS, PC A02/MF A01.

The abundances of anomalous light, $Z > 1$ nuclei that would be produced by primordial cosmic nucleosynthesis if there exist neutral, stable, strongly interacting baryons are calculated. The light element most sensitive to a small primordial abundance of such a baryon is beryllium.

PLANETARY PHENOMENA

REFER ALSO TO CITATION(S) 10706

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

10709 (AD-A—070180) **Auroral data analysis. Final report, 1 August 1975-31 January 1979.** Winningham, J.D.; Shepherd, G.G. (Texas Univ., Dallas (USA). Richardson Center for Advanced Studies). 26 Mar 1979. Contract F19628-76-C-0005. 151p. NTIS PC A08/MF A01.

On the basis of the ISIS-1 and 2 data set it has been possible to meet the goals set forth in this contract. The particle-optical empirical relationships derived can be used to relate 6300A emissions to low-energy (<300 eV) fluxes in a quantitative way and vice versa. If suitable ionization production models were available, then < 300 eV energy fluxes 'images' derived from concurrent 6300A images could be utilized to predict F-region behavior. One possible result would be the derivation of an estimate of F0F2 during darkened conditions. This result along with the local time position of the trough would allow an estimate of the severity of scattering from the steep poleward wall of the trough and the fluctuations embedded in it. Knowledge of the IMF B/sub z/ component in near real time would allow a dynamic 'prediction' of the trough wall. Such a prediction could be used to allow reconfiguration of systems affected by the trough wall and fluctuations at or near it.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

10710 Triplet—triplet absorption of pyrazine related to the n/sub +/π (B/sub 3u/) —n/sub -/π (B/sub 2g/) splitting. Inoue, A.; Webster, D.; Lim, E.C. (Department of Chemistry, Wayne State University, Detroit, Michigan 48202)). *J. Chem. Phys.;* **72**: No. 2, 1419-1420(15 Jan 1980).

The triplet triplet absorption of pyrazine in the region 230—1900 nm is reported. (AIP)

10711 Gas phase structure of transition metal dihydrides. Demuynck, J.; Schaefer, H.F. III. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **72**: No. 1, 311-315(1 Jan 1980).

ESR and infrared spectroscopic measurements on matrix isolated MnH_2 and CrH_2 have recently suggested that these simple molecules may be bent. This result would be the opposite of that found experimentally for the transition metal dihalides MX_2, known to be linear. Here the geometrical structure of MnH_2 has been investigated by molecular electronic structure theory. A large contracted Gaussian basis set [Mn(14s11p6p/9s8p3d), H(5s1p/3s1p)] was used in conjunction with self-consistent field and configuration interaction methods. These suggest that the $^6A_1$ ground state of MnH_2 is linear. Further studies of the $^3A_1$ state (one of several low-lying states) of TiH_2 also favor linearity, although this potential energy surface is extremely flat with respect to bending. Thus it appears probable that most MH_2 molecules, like the related MX_2 family, are linear.

10712 Reply to a Comment by Milonni on "A classical/semiclassical theory for the interaction of infrared radiation with molecular systems". Miller, W.H. (Department of Chemistry and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **72**: No. 1, 788-789(1 Jan 1980).

The classical model for describing the interaction of molecules with infrared radiation, proped, by the author is further explored and Milonni's comments are taken into consideration. (AIP)

BEAMS AND THEIR REACTIONS

10713 (CONF-790843—13(Draft)) **Near surface yield enhancement in narrow acceptance 180° elastic scattering for He ions in noncrystalline and poly-crystalline solids.** Pronko, P.P.; Appleton, B.R.; Holland, O.W.; Wilson, S.R. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 15p. Dep. NTIS, PC A02/MF A01.

From 8. international conference on atomic collisions in solids; Hamilton, Canada (13 Aug 1979).

Observations of an unusual near-surface ($0 \leq x \leq 700$A) yield enhancement in the energy distribution of elastically scattered He ions from amorphous and polycrystalline materials is reported. The integrated excess yield for small (θ/sub 1/2/ = 0.2°) versus large (θ/sub 1/2/ = 4.5°) acceptance angle at 180° scattering is typically 20% for He energies in the range $0.2 \leq E \leq 2.5$ MeV. Maximum peak-to-normal yield ratios as high as 60 to 70% were observed. Materials in which the effect was observed include amorphous germanium, the glassy metal alloy $Nb_{40}Ni_{60}$, fine-grained polycrystalline Au, Pt, Mo, and Cu, and also single crystals of Si and Au continuously rotated during data collection to simulate a random lattice. The excess yields are largest for materials of atomic number above $Z = 40$, and decreases rapidly for elements below this value. The angular width and depth dependences of this effect suggest that it is sensitive to multiple scattering and also imply that the particle, upon scattering, must retrace its inward path within a cone of $\leq 0.2°$ from depths comparable to or less than a few hundred Angstroms. 5 figures.

10714 (COO—1198-1283) **Studies in the theory of solids.** Hjalmarson, H.P. (Illinois Univ., Urbana (USA). Dept. of Physics). 1979. Contract EY-76-C-02-1198. 263p. Dep. NTIS, PC A12/MF A01. Thesis.

The surface arrangement of atoms in a solid controls the energetically slowly varying features of a LEED spectrum. Because of inelastic collisions within the solid, the LEED electrons mainly sample a surface sandwich of atoms. Thus, the surface sandwich reflectivity, computed by using a method which considers only single reflections of the electron by sheets of atoms in the solid, can be directly compared with the slowly varying, surface dependent features in the data. The method was used to determine that the surface of TiS_2 is ideal whereas the surface sandwich of $TiSe_2$ expands outward slightly. For the final determinations, the smoothing method was used on both the data and a theory which includes multiple scattering to confine the comparison to just the slowly varying surface dependent features. Energies of deep traps associated with impurities in semiconductors are shown to be controlled by the S and P orbital energies of the impurity atoms. First, the

qualitative physics of a deep trap is worked out using a defect molecule model. The quantitative theory is worked out using a tight binding Koster-Slater calculation. Predictions of energies of deep traps caused by impurities are made for fourteen different semiconductors. The theory is compared with the data for GaP and the alloy GaAs/sub 1-x/P/sub x/ before developing a phenomenological model which depends mainly on the energy centers of the valence and conduction band density of states as well as atomic energies of impurities. This phenomenological model is used to make predictions of deep trap energies in Si.

10715 Development of a supersonic O(^{3}P/sub J/), O(^{1}D$_2$) atomic oxygen nozzle beam source. Sibener, S.J.; Buss, R.J.; Ng, C.Y.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). W-7405-ENG-48. *Rev. Sci. Instrum.;* **51**: No. 2, 167-182(Feb 1980).

A high pressure, radio frequency discharge nozzle beam source has been developed for the production of very intense (> or $=10^{18}$ atoms sr^{-1} s^{-1}) supersonic beams of oxygen atoms. An efficient impedance matching scheme has been devised for coupling the radio frequency power to oxygen—rare gas mixtures as a function of gas pressure, temperature, and composition. Techniques for localizing the discharge directly behind the orifice of a specially designed quartz nozzle have also been developed. The above combine to yield a beam source which reliably produces a high degree of molecular dissociation in oxygen—rare gas mixtures at pressures up to 350 Torr. Atomic oxygen mean translational energies from 0.14—0.50 eV have been achieved using the seeded beams technique with Mach numbers up to 10 being realized. When helium is used as the carrier gas both O(^{3}P/sub J/) and O(^{1}D) are present in the beam, while only ground state atoms appear to be present in argon seeded mixtures. This paper describes the design, construction, and operation of this beam source and provides a characterization of the atomic oxygen beams it has reproducibly generated in our laboratory.

10716 Discussion of the origin of secondary photon and secondary ion emission during energetic particle irradiation of solids. I. The collision cascade. Wright, R.B.; Gruen, D.M. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **72**: No. 1, 147-171(1 Jan 1980).

Secondary photon and secondary ion emission during energetic particle irradiation of solid surfaces is assumed to arise due to excitation and de-excitation of sputtered particles originating from a collision cascade induced by the incident projectile. The excitation is postulated to occur by two alternative mechanisms: path (a), where excitation occurs at or very near the surface of the solid due to atom—atom or atom—electron collisions; and path (b), where excitation occurs as the sputtered particle leaves the solid, but is still under its influence so that electron exchange processes are permitted. Once the excited and/or ionized sputtered particle is formed nonradiative de-excitation processes are then included in the discussion which allow the excited and/or ionized particle to be de-excited and/or neutralized. The result of these nonradiative de-excitation processes is shown to provide a possible channel for the formation of new excited "daughters" by the de-excitation of the initial excited "parent". Depending on the initial excitation probability of the parent the new excited daughters are shown to contribute to various energy regions of the excited and/or ionized secondary particle energy distribution. A mathematical formalism is developed based on the neutral sputtered atom energy and velocity distributions assuming a collision cascade origin for these sputtered particles. By including various models for the excitation probability, and the survival probability for excited particles once formed to not undergo nonradiative de-excitation the resulting energy and velocity distributions of the sputtered excited and/or ionized secondary particles are calculated. These distributions are found to be a function of the emission angle depending on the model assumed for the initial excitation. From this formalism the total excited secondary particle yield may be calculated.

10717 Filament chucks for multifilament ion sources. Conrad, J.R.; Horne, S.F.; Pirkle, D.R.; Torti, R.P. (Nuclear Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). *Rev. Sci. Instrum.;* **51**: No. 1, 144-145(Jan 1980).

A simple method for fabricating filament chucks for multifilament ion sources is described.

10718 Electron-scattering cross sections pertinent to electron micrsocopy. Inokuti, M. (Argonne National Lab., IL (USA)). *Ultramicroscopy;* **3**: No. 4, 423-427(1978).

Some elements of the physics that determine cross sections are discussed, and the various sources of data that should be useful for analytical micrsocopy are indicated. The discussion concerns atoms, molecules, and to some extent, solids.

ATOMIC AND MOLECULAR PROPERTIES

10719 High-temperature Raman spectroscopic studies of indium halide vapors and molten salts: InX, InX$_2$, InX$_3$, and InAlX$_4$ (X=Cl, Br). Radloff, P.L.; Papatheodorou, G.N. (Chemical Engineering Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **72**: No. 2, 992-1000(15 Jan 1980).

Raman spectra were obtained at temperatures up to 1200 K for vapors over liquid indium halides with In:X (X=Cl, Br) ratios of 1:1, 1:2, and 1:3 and for vapors over liquid InAlX$_4$. Spectra were also measured for molten InX$_2$ and InAlX$_4$ salts. The spectra of InX vapors consisted of O, Q, and S vibrational—rotational contours with maxima at $\Delta\nu$/sub Q/(InCl) =305 cm^{-1} and $\Delta\nu$/sub Q/(InBr) =213 cm^{-1}. Pure rotational O and S band contours were also resolved at frequencies close to the frequency of the laser excitation line. Vibrational—rotational contours for the InX molecules were simulated using known molecular constants and accounting for contributions of both trace and anisotropic scattering. Preresonance enhancement of the Raman intensities and changes in the "linear" depolarization ratio with laser frequency were also observed for the InX molecules. The spectra of vapors over InX$_3$ were characteristic of a dimer—monomer indium (III) halide equilibrium. Raman spectra of vapors over InX$_2$ and InAlX$_4$ liquids show the formation of vapor complexes and vapor dissociation according to the reactions: A comparison of the Raman spectra of liquid InX$_2$ and InAlX$_4$ with the corresponding spectra of the vapors indicates that the same molecular species are present in both phases.

10720 Quasi-cw inverse Raman spectroscopy of the ν_1 fundamental of $^{13}CH_4$. McDowell, R.S.; Patterson, C.W.; Owyoung, A. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **72**: No. 2, 1071-1076(15 Jan 1980).

A Doppler-limited Raman spectrum of the symmetric stretching fundamental (ν_1) of $^{13}CH_4$ has been recorded using high-sensitivity "quasi-cw" inverse Raman spectroscopy. The band is very different in appearance from ν_1 of $^{12}CH_4$, due mainly to a much smaller value of ΔB for the heavier species, which causes many of the transitions to overlap near the band origin. Line assignments have been made for $J <$ or $= 11$. The spectroscopic constants have been determined from the frequencies of 25 resolved transitions and a computer synthesis of the largely unresolved central region. The observed $^{12}C—^{13}C$ isotope shift, 1.04 +- 0.02 cm^{-2}, does not agree completely with predictions based on any available set of anharmonicity constants, but it does indicate that a simplified calculation based on a Dennison-type approximation for the anharmonicity constants of isotopic species is not valid. The large difference in ΔB between the two species is attributed to the effect of Coriolis interaction with the nearby combination level $\nu_2+\nu_4$.

10721 Photoexcitation and ionization in molecular fluorine: Stieltjes—Tchebycheff calculations in the static-exchange approximation. Orel, A.E.; Rescigno, T.N.; McKoy, B.V.; Langhoff, P.W. (Theoretical Atomic and Molecular Physics Group, Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Chem. Phys.;* **72**: No. 2, 1265-1275(15 Jan 1980).

Theoretical investigation of outer (1π/sub g/, 1π/sub u/, 3σ/sub g/) and inner (2σ/sub u/, 2σ/sub g/) valence-shell electronic photoexcitation and ionization cross sections in molecular fluorine are reported employing separated-channel static-exchange calculations and Stieltjes—Tchebycheff (S—T) moment-theory techniques. The discrete vertical electronic 1π/sub g/ excitation series are found to be in good agreement with recent spectral assignments and previously reported theoretical studies, and those for 1π/sub u/, 3σ/sub g/, 2σ/sub u/ and 2σ/sub g/ excitations are in general accord with position and intensity estimates based on quantum-defect analysis. Certain of the partial-channel photoionization cross sections in F_2 are seen to exhibit resonancelike features similar to those reported recently in related S—T studies of photoionization in N_2, CO, and O_2. The resonances can be attributed to valencelike and pre-Rydberg diabatic states that cross the outer limbs of appropriate Rydberg series and corresponding ionic-state potential curves as functions of internuclear coordinate, giving rise to large continuum transition intensities at the ground-state equilibrium internuclear separation. In contrast to the situation in N_2, CO, and O_2, however, there is no evidence of a resonance like $\sigma\rightarrow\sigma^*$ feature in the 3σ/sub g/$\rightarrow k\sigma$/sub u/ photoionization channel in F_2. Rather, this resonance in F_2 appears as a strong N$\rightarrow$V/sub g/ transition below the 3σ/sub g/ ionization threshold, and the corresponding partial-channel photoionization cross section is seen to be structureless.

10722 Rotational relaxation in sonic nozzle expansions. Klots, C.E. (Chemical Physics Section, Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Chem. Phys.;* **72**: No. 1, 192-197(1 Jan 1980).

The thermal conduction model for cooling in sonic nozzle expansions is extended to rotational degrees of freedom. Unimolecular decomposition theory, as applied to collision complexes, provides a natural formalism for describing the rotational—translational cou-

pling. Simple expressions are presented for the terminal "temperatures" as functions of the source parameters and the relevant long-range r^{-6} potential. Extensions to other potentials and to vibrational relaxation are indicated.

10723 Resonance peak shapes in molecular photoionization mass spectroscopy. Eland, J.H.D.; Berkowitz, J.; Monahan, J.E. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **72**: No. 1, 253-259(1 Jan 1980).

Some autoionizing resonances are observed in different fragment ion channels with different shapes and peak positions. It is shown that a simple parametrization yields consistent resonance energies and widths independent of the channel and that peak shapes vary systematically with the relative intensity of the resonance and the continuum in the channel observed.

10724 Gas phase infrared spectra of ammoniated ammonium ions. Schwarz, H.A. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *J. Chem. Phys.;* **72**: No. 1, 284-287(1 Jan 1980).

Infrared spectra of 2—5 μ are reported for $NH_4(NH_3)$/sub n/ $^+$, n=0 to 4. The ν_3 mode is found at 3335 cm^{-1} in NH_4^+, 2867 cm^{-1} in $NH_4(NH_3)_4^+$. The ν_3' modes in $NH_4(NH_3)_3^+$ are found at 2682 and 3365 cm^{-1} and the ν_1' mode is found at 2790 cm^{-1}. The overtone band $2\nu_4$ is observed at 3087 cm^{-1} in the n=4 species and 3000 cm^{-1} in the n=3 species. Isotope effects are reported. Less detailed spectra are reported for n=1 and n=2 species.

10725 Radiative lifetime of metastable 2 $^3S_1$ Li^+. Knight, R.D.; Prior, M.H. (Department of Physics, University of California, and Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., A;* **21**: No. 1, 179-187(Jan 1980).

The radiative lifetime of 1s2s $^3S_1$ Li^+ ions has been measured by a comparison of the count rate of spontaneous decay photons (210 A) to a laser-induced fluorescence signal proportional to the total number of metastable ions. The ions were confined in a rf-quadrupole trap, and the fluorescence signal used was the intercombination transition 1s2p $^3P_1$ to $1s^2$ $^1S_0$ at 202 A. The $^3P_1$ state was populated from $^3S_1$ by absorption of laser photons at 5485 A. The result is tau/sub r/=58.6 +- 12.9 sec (95% confidence level); theory predicts tau/sub r/=49.1 sec.

10726 New line classifications and energy levels in the triplet system of Xe VII. Knystautas, E.J.; Sugar, J.; Roberts, J.R. (Center for Radiation Research, National Bureau of Standards, Washington, D.C. 20234). *J. Opt. Soc. Am.;* **69**: No. 12, 1726-1727(Dec 1979).

A number of VUV lines, produced in a theta-pinch plasma, have been identified in the triplet system of Cd-like Xe VII. They serve to establish the positions of all the 5s5p $^3P^0$, $5p^2$ ^3P, 5s6s ^3S, and 5s5d ^3D levels. An ionization energy of 743 000 +- 6000 cm^{-1} (92.1 +- 0.8 eV) is derived from these observations.

10727 Two-photon coherent-transient measurement of the nonradiative collisionless dephasing rate in SF_6 via Doppler-free degenerate four-wave mixing. Steel, D.G.; Lam, J.F. (Hughes Research Laboratories, Malibu, California 90265). ED-78-C-08-1563. *Phys. Rev. Lett.;* **43**: No. 21, 1588-1591(19 Nov 1979).

This Letter reports, for the first time, an experimental measurement of the collisionless dephasing time of the ν_3=2 level in SF_6 using Doppler-free two-photon degenerate four-wave mixing. The measurement is performed in the time domain by use of a short-pulse CO_2 laser to establish a molecular two-photon coherent state. The coherent state is then probed as a function of time to yield a dephasing time of 1.8 nsec which is related to intramolecular dephasing rates.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

10728 (COO—2875-12) Study of muonic atoms in the A = 40 - 70 and A = 100 - 130 mass regions (nuclear charge radii, isotope and isotone shifts) and in the Sm-Gd and W-Os-Pt transition regions (electric monopole and quadrupole moments). Progress report, November 15, 1978-December 1, 1979. Steffen, R.M. (Purdue Univ., Lafayette, IN (USA). Dept. of Physics). Dec 1979. Contract EY-76-S-02-2875. 39p. Dep. NTIS, PC A03/MF A01.

During the reporting period the muonic x-ray measurements on ^{106} ^{108} ^{110} ^{111} ^{112} ^{113} ^{114} ^{116}Cd and ^{122} ^{124} ^{125} ^{126} ^{128} ^{130}Te have been completed and the data were analyzed in terms of effective Barrett charge radii. The muonic x-ray spectra of ^{154} ^{155} ^{156} ^{157} ^{158}Gd have been measured with high precision. Special methods were developed to extract isotopically clean spectra from the measurements with the separated Gd target which contained large amounts of isotopic impurities. The even-A Gd spectra have been analyzed in terms of nuclear monopole and quadrupole parameters and isomer shifts. Additional studies of the nuclear polarization corrections in muonic ^{208}Pb have been made. The isomer shift of the excited 2^+ state of ^{204}Pb has been measured: ΔE/sub iso/ = 1.98 +- 0.16 keV. The transfer of muons stopped in liquid hydrogen to Au nuclei contained in thin foils (30 $\mu g/cm^2$) that are suspended in the liquid hydrogen has been observed. About 20 times more muonic Au atoms were produced in this LH_2-Au arrangement as compared to a solid Au target of the same mass.

10729 Detection of EPR transitions of muonium in quartz by muon-spin rotation. Brown, J.A.; Heffner, R.H.; Leon, M.; Dodds, S.A.; Vanderwater, D.A.; Estle, T.L. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **43**: No. 23, 1751-1754(3 Dec 1979).

We have detected magnetic resonance transitions of muonium in quartz by their effect on muon spin rotation frequency spectra. This technique can be used to observe electron paramagnetic resonance transitions which are not directly observable in the normal μSR spectrum. The coherence effects of an intense rf magnetic field on two strongly-coupled spins are described theoretically and are found to explain the data in detail.

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 10436, 10995

10730 (CONF-790889—2) Recent work with fast molecular-ion beams at Argonne National Laboratory. Cooney, P.J.; Gemmell, D.S.; Groeneveld, K.O.; Kanter, E.P.; Pietsch, W.J.; Vager, Z.; Zabransky, B.J. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 34p. Dep. NTIS, PC A03/MF A01.

From Workshop on physics with fast molecular-ion beams; Argonne, IL, USA (20 Aug 1979).

Research in these areas during 1979 is summarized: (a) studies of molecular-ion dissociation in gaseous targets, (b) developing an understanding of the origins of central peaks and of the two phenomena of the transmission of fast molecular ions through thin foil targets and of the production of neutral fragments from collision-induced dissociation of fast molecular projectiles, (c) studies exploring the extent to which high-resolution measurements on dissociation fragments can be used to determine the stereochemical structures of the molecular ions in the incident beam, (d) extensive modifications to the beam-line and apparatus at the 4-MV Dynamitron so as to permit a wide variety of coincidence measurements on fragments from collision-induced molecular-ion dissociation.

10731 (LA-UR—79-3161) L^2 approach to R-matrix propagation: followup report. Walker, R.B. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 11p. Dep. NTIS, PC A02/MF A01.

A hybridized R-matrix propagation program was used to solve the four test problems presented by the NRCC workshop on close coupling methods. The hybrid method used both the L^2 approach reported earlier and the analytic (constant reference potential) method. Observations on the utility of the hybrid approach are presented. 2 references.

10732 (LBL—9819) Quenching of metastable rare gases by calcium atoms and metal carbonyls. Hartman, D.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.; California Univ., Berkeley (USA). Dept. of Chemistry). Oct 1979. Contract W-7405-ENG-48. 147p. Dep. NTIS, PC A11/MF A01.

Thesis.

A flowing afterglow chemiluminescence apparatus was used to study three important processes, associative ionization, Penning ionization, and collisional dissociation. The metastable rare gases Ar, Ne and He were used as energy donors.

10733 Dissociation of metal carbonyls by metastable rare gases: Fe and Ni emission analysis. Hartman, D.C.; Hollingsworth, W.E.; Winn, J.S. (Department of Chemistry, University of California and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *J. Chem. Phys.;* **72**: No. 2, 833-842(15 Jan 1980).

Chemiluminescence from $Ni(CO)_4$ and $Fe(CO)_5$ collisions with metastable He, Ne, and Ar atoms is described. The emission spectra are due to atomic Ni and Fe. An analysis of these spectra indicate a dissociative energy transfer process which is not spin—differentiated among the metal atom states. Because of this, certain low-lying quintet states are seen here in emission for the first time. Steady state population analysis of all features permits a determination of the radiative lifetimes of these new states. For both carbonyls, a restricted statistical rate theory, in which the CO fragments are allowed to translate in one dimension only (the radial reaction coordinate) and are prohibited from rotating, gives good agreement with all the data. The nature of metastable electronic energy transfer is compared to photolytic energization, and a comparison of the likely excited electronic states involved in each indicates the source of the differences in product distributions observed by each method.

10734 Collisional relaxation of low lying electronically excited states of uranium: $f^3ds^2(^5K^0_5)$ and $(^5L_7^0)$. Chen, H.; Borzileri, C. (University of California, Lawrence Livermore Laboratory, Liver-

more, California 94550). W-7405-ENG-48. *J. Chem. Phys.;* **72**: No. 2, 853-857(15 Jan 1980).

Laser induced fluorescence techniques have been used to measure the rates of electronic relaxation of atomic uranium in a beam-gas scattering apparatus. Cross sections for the collisional deactivation of the U $f^3ds^2(^5K_8^o)$ and $(^5L_7^o)$ states by H_2, D_2, HD, CH_4, N_2, and CO at room temperature are reported. Upper limits for quenching cross sections with He were also obtained. Relaxation of these uranium metastables by molecular hydrogen (H_2, D_2, and HD) and methane appears to proceed by resonant electronic-to-rotational or electronic-to-vibration/rotational energy transfer processes.

10735 Collisional relaxation of highly excited uranium atoms in gases. Chen, H.; Borzileri, C. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). W-7405-ENG-48. *J. Chem. Phys.;* **72**: No. 2, 858-860(15 Jan 1980).

A laser induced fluorescence technique has been used to measure the electronic relaxation rates of highly excited uranium atoms. Cross sections for the collisional deactivation of atomic uranium in the 15 632 and 24 560 cm^{-1} states by He^3, He^4, H_2, D_2, Ne, and CH_4 at room temperature are reported. Relaxation of these high lying states by foreign gases is very efficient and is likely governed by an inter-state-mixing process leaving the excited uranium atoms in very close lying neighboring levels.

10736 Experimental confirmation of the Jahn—Teller distortion of CH_4^+. Gemmell, D.S.; Kanter, E.P.; Pietsch, W.J. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **72**: No. 2, 1402-1404(15 Jan 1980).

We report measured energy and angular distributions for H^+ and C/sup n/+ (n=2,3,4) fragments resulting from the collisional dissociation of 194 keV/amu Ch/sub n/$^+$ (n=0—4) in thin carbon foils. From the systematic trends of these "Coulomb explosion" spectra, one can obtain qualitative information on the structures of these species. In particular, the series displays a narrowing of the carbon angular and energy widths as protons are symmetrically added around a central carbon atom and provide a "focusing" effect. Because of the Jahn—Teller distortion, the widths measured for CH_4^+ are dramatically increased. (AIP)

10737 Elastic-electron-scattering cross sections for N_2 from 0 to 1000 eV. Energy-dependent exchange potentials. Siegel, J.; Dehmer, J.L.; Dill, D. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **21**: No. 1, 85-94(Jan 1980).

Integrated and differential cross sections for vibrationally elastic e^--N_2 scattering from 0 to 1000 eV are calculated by means of the continuum multiple-scattering method (CMSM) with the Hara free-electron-gas and semiclassical exchange approximations. The present results represent a significant improvement over earlier CMSM calculations employing the Slater Xα exchange approximation. The physical basis for this improvement is discussed. Resonance structures appear at 2.4, 13, and 26 eV in the π/sub g/, δ/sub g/, and σ/sub u/ channels, respectively; however, the latter two are very weak and only the σ/sub u/ resonance has been observed in elastic scattering. Agreement between the present calculation and experiment is good over the entire energy range, although at fixed (equilibrium) internuclear distance, the π/sub g/ resonance is too narrow and high. The agreement at the π/sub g/ resonance is significantly improved by taking into account the effects of nuclear motion in the adiabatic nuclei approximation.

10738 Origin of enhanced vibrational excitation in N_2 by electron impact in the 15—35 eV region. Dehmer, J.L.; Siegel, J.; Welch, J.; Dill, D. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., A;* **21**: No. 1, 101-104(Jan 1980).

The authors calculate the integrated vibrational excitation cross section for e-N_2 scattering in the interval 0 —50 eV using the continuum multiple-scattering model with the Hara exchange approximation. Resonant enhancement is observed at 2.4 eV owing to the well-known π/sub g/ shape resonance. In addition, however, enhanced vibrational excitation is found centered at ~26 eV, arising from a broad shape resonance in the σ/sub u/ channel. The authors propose this one-electron feature as the main source of the enhanced vibrational excitation observed by Pavlovic et al. in the 15—35 eV region.

10739 Observation of a collective excitation in the ejected-electron spectra of Yb and Ba. Rosenberg, R.A.; Lee, S.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). *Phys. Rev., A;* **21**: No. 1, 132-139(Jan 1980).

Ejected-electron spectra of Yb and Ba are presented. In both spectra, structure was seen which is attributable to autoionization to ground and excited states of M^+ (M=Ba or Yb), and to Auger decay of highly excited M^{**} states to the ground state of M^{2+}. In Yb, Auger decay was also observed to populate excited states of M^{2+}. Both spectra are strongly affected by a collective resonance in the excitation of a 5p electron. For energies above the 5p ionization threshold, two-step autoionization to M^{2+} was found to be dominant.

10740 Theory of electron—molecule collisions. Lane, N.F. (Physics Department, Rice University, Houston, Texas 77001). *Rev. Mod. Phys.;* **52**: No. 1, 29-120(Jan 1980).

The current state of the theory and its application to low-energy electron—molecule collisions is reviewed. The emphasis is on elastic scattering and vibrational and rotational excitation of small diatomic and polyatomic molecules. New and traditional theoretical approaches are described, and the results of calculations are compared with existing experimental measurements.

10741 Observation of narrow resonances in the H^- photodetachment cross section near the n=3 threshold. Hamm, M.E.; Hamm, R.W.; Donahue, J.; Gram, P.A.M.; Pratt, J.C.; Yates, M.A.; Bolton, R.D.; Clark, D.A.; Bryant, H.C.; Frost, C.A.; Smith, W.W. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **43**: No. 23, 1715-1718(3 Dec 1979).

Two pronounced dips in the H^- photodetachment cross section have been observed at photon energies of 12.650 +- 0.004 and 12.837 +- 0.004 eV, just below the hydrogenic n=3 threshold. These energies were reached by crossing a UV laser beam with a relativistic H^- beam. The dips are interpreted as the first two members of a ^1p Feshbach resonance series, of the "+" type, converging on n=3. Fano line shapes have been fitted to these structures to extract their intrinsic widths and line profile indices.

10742 Theoretical study of spin polarization of photoelectrons from noble gases. Huang, K.; Johnson, W.R.; Cheng, K.T. (Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556). *Phys. Rev. Lett.;* **43**: No. 22, 1658-1661(26 Nov 1979).

Recent measurements by Heinzmann, et al., of the spin polarization of photoelectrons ejected from xenon by unpolarized light are in serious disagreement with various theoretical calculations. In this letter we report an ab initio study of spin polarization using the relativistic random-phase approximation (RRPA). Excellent agreement is obtained between the present calculations and the experimental measurements by Heinzmann et al. for xenon, krypton, and argon.

10743 Angular distribution of Xe 5s → εp photoelectrons near the Cooper minimum. White, M.G.; Southworth, S.H.; Kobrin, P.; Poliakoff, E.D.; Rosenberg, R.A.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 22, 1661-1664(26 Nov 1979).

Angular distributions of Xe 5s → εp photoelectrons were measured at energies near the Cooper minimum, using pulsed synchrotron radiation and a time-of-flight photoelectron spectrometer. The asymmetry parameters β/sub 5s/ differ markedly from the nonrelativistic value of 2, particularly near the Cooper minimum, in agreement with theoretical models based on jj coupling. Comparison to recent relativistic calculations confirms the relativistic random-phase approximation model of Johnson and Cheng, establishing the importance of interchannel coupling in the 5s → εp photoionization process.

ATOMIC AND MOLECULAR THEORY

10744 Note on spin-flip electric dipole transitions. Friar, J.L. (Los Alamos Scientific Lab., NM (USA). Theoretical Div.). *Z. Phys., A;* **291**: No. 1, 1-4(1979).

A simplified derivation is given of the spin-flip electric dipole transition matrix element to order (α^3), which stresses general principles and the atomic change operator. Relativistic corrections of order $(v/c)^2$ are necessary. The previous result of Drake for helium-like ions is verified.

10745 General theory of the spectroscopic properties of partially ordered ensembles. I. One vector problems. Friesner, R.; Nairn, J.A.; Sauer, K. (Laboratory of Chemical Biodynamics, Lawrence Berkeley Laboratory, and Department of Chemistry, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **72**: No. 1, 221-230(1 Jan 1980).

We have developed a method for determining the response of a static, partially ordered ensemble of molecules to various types of electromagnetic probes. In our formalism a physical model is constructued for the orientational distribution function, which is represented as a volume integral over a set of weighting functions. Procedures are given for obtaining geometrical and statistical parameters from analysis of the oriented line shapes and intensities. Explicit treatments of linear dichroism, circular dichroism, and magnetic resonance are developed as well as detailed mathematical techniques for calculation of the distribution function.

10746 Radiative decay of hydrogenlike atoms in an electric field. Hillery, M.; Mohr, P.J. (Department of Physics, University of Cali-

fornia, Berkeley, California 94720). *Phys. Rev., A;* **21**: No. 1, 24-33(Jan 1980).

Photon emission by an atom in the metastable 2S state in a weak static electric field is examined within the context of bound-state quantum electrodynamics. Low's method is applied to obtain the expansion in terms of Coulomb wave functions of the propagation function for an electron interacting with the nuclear Coulomb field, the applied electric field, and the quantized radiation field. For a weak applied field, and to lowest relative order in α/π, the 2S-state resonant contribution to the propagation function can be factorized to provide the basis for a calculation of the angular distribution of single-photon radiation and lifetime of the excited state. A numerical evaluation is given, which takes into account effects of electric dipole, magnetic dipole, and magnetic quadrupole emission, relativistic corrections, and finite level widths.

10747 Atomic motion in resonant fluctuating laser radiation. Cook, R.J. (University of California, Lawrence Livermore Laboratory, P.O. Box 5508, Livermore, California 94550). *Phys. Rev., A;* **21**: No. 1, 268-273(Jan 1980).

The effect of field fluctuations on the motion of a two-level atom in resonant laser radiation is investigated theoretically. The internal motion of the atom is treated quantum mechanically (optical Bloch equations); the translational motion, which is coupled to the internal motion, is treated classically (Ehrenfest's theorem); and the fluctuating radiation is treated as a classical electromagnetic wave with stochastic phase (phase-diffusion model). An expression for the radiation force and equations of motion for the ensemble-averaged Bloch vector are derived and used to calculate (i) the radiation force in a plane running wave, (ii) the steady-state radiation force in a general standing wave, and (iii) the dissipative force in a plane standing wave in the limit of strong phase fluctuations. In case (iii) it is found that the atomic velocity is damped when the radiation is tuned above resonance, which is opposite to the case of a weak coherent standing wave, in which damping occurs for radiation tuned below resonance. It is shown that fluctuations have a substantial effect on the radiation force only when the spectral width of the radiation approaches or exceeds the spontaneous emission rate.

10748 Selective excitation of multiple-quantum coherence in nuclear magnetic resonance. Warren, W.S.; Sinton, S.; Weitekamp, D.P.; Pines, A. (University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 24, 1791-1794(10 Dec 1979).

Wideband selective n-quantum excitation in the NMR of coupled spins is demonstrated for the first time. By a combination of multiple pulse averaging and phase shifts phi a pure n-quantum excitation operator can be produced (n=2π/phi). This allows enhancement of normally weak n-quantum transitions. Selective excitation of the zero- and four-quantum transitions in benzene illustrates this approach. Extensions to selective absorption of only groups of n-photons in other regimes of spectroscopy are straightforward, in principle.

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 10314, 10954

10749 (DOE/MC/11842—T2) **Investigation of acoustic aerosol agglomeration mechanisms under traveling-wave condition.** Shaw, D.T. (State Univ. of New York, Buffalo (USA)). 4 Jan 1980. Contract AC21-79MC11842. 22p. Dep. NTIS, PC A02/MF A01.

Acoustically induced turbulence and shock waves are experimentally studies using hot-film anemometer and the following results obtained. (a) Shock waves and turbulence in a resonance tube can occur only when the sound pressure level passes a certain threshold value. The critical SPL for turbulence is ~ 158 dB which is slightly lower than SPL ≈ 160 dB for the shock wave formation. (b) Shock waves are found to be insensitive to frequency variations in contrast to standing waves where shock waves appear only within a narrow band around the resonance frequencies. (c) Isotropy of turbulence is checked by plotting spectrum against dimensionless frequency f/sub t/ of turbulence. In the inertial subrange, it is found that PSD α f/sub t//sup α/ with an average $\alpha = 1.85$ which is only 10% from the theoretical value of -5/3 [4]. (d) The rms turbulent velocity u/sub */ has a functional dependence of I as u/sub */ α I/sup 1/2/ regardless of locations but insensitive to variations of frequency. (e) The Reynolds number R in the form given by Merkli is found to be between 60 and 150 at the onset of acoustically induced turbulence. (f) The combined effect of turbulence and shock waves may have a vast influence on the agglomeration rate of aerosol particles. (g) A superimposed laminar flow onto the acoustically induced turbulence would suppress the turbulence under both traveling and standing wave conditions.

PROPERTIES AND STRUCTURE OF FLUIDS

10750 Properties of clusters in the gas phase. IV. Complexes of H_2O and HNO/sub x/ clustering on NO/sub x/$^-$. Lee, N.; Keesee, R.G.; Castleman, A.W. Jr. (Department of Chemistry and Chemical Physics Laboratory, CIRES, University of Colorado, Boulder, Colorado 80309). *J. Chem. Phys.;* **72**: No. 2, 1089-1094(15 Jan 1980).

Thermodynamic quantities for the gas-phase clustering equilibria of NO_2^- and NO_3^- were determined with high-pressure mass spectrometry. Comparison of ΔG^0/sub n/,n+1 values derived from our data shows good agreement with formerly reported values at 296 °K. New data for larger NO_2^- and NO_3^- hydrates as well as $NO_2^-(HNO_2)$ were obtained in this study. To aid in understanding the bonding and stability of the hydrates of nitrite and nitrate ions, CNDO/2 calculations were performed, and the results are discussed herein. A correlation between the aqueous phase total hydration enthalpy of a single ion and its gas-phase hydration enthalpy was obtained. Atmoshperic implications of the data are also briefly discussed.

10751 Spatial distribution of plasma in a transverse-discharge supersonic nitrogen stream. Garcia, M. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **51**: No. 1, 223-236(Jan 1980).

Experimental and theoretical studies were conducted on plasma in a supersonic channel containing a transverse plate discharge and localized pin-discharge ionizers. The goal was to determine the mechanism by which the plasma was created and distributed in such a discharge channel, where a nitrogen flow and both discharges operated continuously. Spatially resolved measurements of neutral density ($N \simeq 10^{18}$ cm^{-3}), flow velocity ($u \simeq 540$ m/s), voltage distribution between the discharge plates (voltage drop ≃2 kV), and plasma density distributions have allowed for the determination of such plasma properties as the ratio of electric field to total number density ($E/N \simeq 10^{-16}$ V cm^2), the ambipolar diffusion coefficient (D/sub a/ ≃40 cm^2/s at $N \simeq 10^{18}$ cm^{-3}), and the average electron energy ($\epsilon \simeq 0.1$ eV). The experimentally determined plasma density distributions are shown to be consistent with the predictions of a continuum quasineutral convection-diffusion model with pin-discharge source terms. The theory models all the major features of the plasma flow in the discharge channel, and can be used for future design studies of potential laser devices.

10752 New similarity method for analysis of multi-dimensional solidification. Shamsundar, N.; Srinivasan, R. (Department of Mechanical Engineering University of Houston Houston, Texas 77004). EG-77-C-04-3974/EFT-5. *J. Heat Transfer;* **101**: No. 4, 585-591(Nov 1979).

There are many multi-dimensional phase change problems which are of interest in applications but cannot be solved by even the powerful computational techniques that are available today. A new similarity rule is presented in this paper to make the solution of such problems possible. The similarity rule applies to problems in which sensible heat contributions are much smaller than latent heat contributions, and the heat flux distribution on the surface of the phase change substance is more or less uniform. After a derivation of the similarity rule is given, it is verified by application to some problems arising in latent heat storage for which finite-difference computations have been performed previously. The similarity rule is easy to apply, and greatly reduces the effort needed in analysing phase change problems. In conjunction with the energy conservation principle, the similarity rule provides an efficient tool for analysing the time-response of a phase change system to arbitrarily varying heat loads, as is demonstrated by examples.

SUPERFLUIDITY

10753 (DOE/TIC—11058) **Elementary excitations in liquid ^{3}He.** Skoeld, K.; Pelizzari, C.A. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 34p. Dep. NTIS, PC A03/MF A01.

The two isotopes of helium offer unique opportunities to test fundamental theories of quantum fluids. In the case of liquid ^{4}He, a Bose liquid, the elementary excitations have been studied extensively over the last two decades by neutron inelastic scattering. Similar studies of liquid ^{3}He, the Fermi liquid counterpart of liquid ^{4}He, have become possible only recently. From the results obtained so far for normal liquid ^{3}He the existence of zero sound as a well defined density excitation at finite wave-vectors (q ≈ q/sub F/) and finite temperatures (T ≈ T/sub F/) has been verified and the spin fluctuation spectrum has been measured. By comparing the neutron scattering results for the density fluctuation spectrum to RPA calculations with generalized polarization potentials important information has been obtained about the effective spin-symmetric interaction between ^{3}He atoms. The spin fluctuation spectrum is in agreement with the paramagnon model if a value close to unity is assumed for

the contact dimensionless paramagnon parameter anti I. This implies that the nuclear spin system in normal liquid ^{3}He is close to ferromagnetic.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

10754 (UCR—34-P107-232) **Annual report on Contract DOE EY-76-S-03-0034 PA 107, January 1, 1978-December 31, 1978.** Kernan, A.; Poe, R.T. (California Univ., Riverside (USA)). Jan 1979. Contract EY-76-S-03-0034-107. 31p. Dep. NTIS, PC A03/MF A01.

The research program during the year 1978 is smmarized. Major effort was devoted to the following three activities: high-energy heavy-ion physics (study of multiple pion production and pion production mechanism, pion interferometry, and central collision events); the Lampshade Magnet - a large-acceptance electron-hadron spectrometer for the ISR; and a general PEP detector based on the time projection chamber (the facility, physics goals, UCR group responsibility, and progress to date). Completed work is published in the usual channels. 4 figures. (RWR)

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 10778, 10779

10755 (COO—3064-036) **Results on charmonium from the Crystal Ball.** Kiesling, C.M. (Stanford Linear Accelerator Center, CA (USA)). Aug 1979. Contract EY-76-C-02-3064. 10p. (CONF-790642—7; SLAC-PUB—2386). Dep. NTIS, PC A02/MF A01.

From International conference on high energy physics; Geneva, Switzerland (27 Jun 1979).

Results from the Crystal Ball experiment at SPEAR are presented. A preliminary analysis of the 3 photon final state from the J/psi(3095) and of the cascade decays of the psi'(3684) yield new upper limits on the controversial states X(2820), chi(3455) and the even C-parity state at 3.59 GeV. From inclusive γ-ray spectra of the J/psi and psi' preliminary branching ratios for psi' → chi states and upper limits for J/psi, psi' → n/sub c/,n/sub c/' are given. 15 references.

10756 (SLAC-PUB—2421) **Results on two-photon interactions from Mark II at SPEAR.** Abrams, G.S.; Alam, M.S.; Blocker, C.A. (Stanford Linear Accelerator Center, CA (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1979. Contract EY-76-C-03-0515. 17p. (CONF-7908102—1; LBL—10016). Dep. NTIS, PC A02/MF A01.

From International conference on two-photon interactions; Lake Tahoe, CA, USA (30 Aug 1979).

Preliminary results on two-photon interactions from the SLAC-LBL Mark II magnetic detector at SPEAR are presented. The cross section for eta' production by the reaction $e^+e^- \rightarrow e^+e^-$ eta' has been measured over the beam energy range from 2 to 4 GeV. The radiative width Γ/sub $\gamma\gamma$/(eta') has been determined to be 5.8 +- 1.1 keV (+- 20% systematic uncertainty). Upper limits on the radiative widths of the f(1270), and A_2(1310) and f'(1515) mesons have been determined.

10757 (SLAC-PUB—2429) **Recent results from the Mark II detector at SPEAR.** Jonathan Dorfan. (Stanford Linear Accelerator Center, CA (USA); California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1979. Contract EY-76-C-03-0515. 26p. (LBL—10132; CONF-7910116—1). Dep. NTIS, PC A03/MF A01.

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

Recent results rom the Mark II Detector at SPEAR are presented. These include measurements of the decays tau$^-$ → rho$^-\nu$/sub tau/ and tau$^-$ → K*$^-$(890)ν/sub tau/, observation of direct photons at the psi, inclusive proton and Λ production and measurements of charmed baryon and charmed meson decays.

10758 **Observation of charmed-baryon production in e^+e^- annihilation.** Abrams, G.S.; Alam, M.S.; Blocker, C.A.; Boyarski, A.M.; Breidenbach, M.; Burke, D.L.; Carithers, W.C.; Chinowsky, W.; Coles, M.W.; Cooper, S.; Dieterle, W.E.; Dillon, J.B.; Dorenbosch, J.; Dorfan, J.M.; Eaton, M.W.; Feldman, G.J.; Franklin, M.E.B.; Gidal, G.; Goldhaber, G.; Hanson, G.; Hayes, K.G.; Himel, T.; Hitlin, D.G.; Hollebeek, R.J.; Innes, W.R.; Jaros, J.A.; Jenni, P.; Johnson, A.D.; Kadyk, J.A.; Lankford, A.J.; Larsen, R.R.; Longo, M.J.; Lueth, V.; Millikan, R.E.; Nelson, M.E.; Pang, C.Y.; Patrick, J.F.; Perl, M.L.; Richter, B.; Roussarie, A.; Russell, J.J.; Scharre, D.L.; Schindler, R.H.; Schwitters, R.F.; Siegrist, J.L.; Strait, J.; Taureg, H.; Tonutti, M.; Trilling, G.H.; Vella, E.N.; Vidal, R.A.; Videau, I.; Weiss, J.M.; Zaccone, H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-ACO3-765FOO515;W-7405-ENG-48. *Phys. Rev. Lett.;* **44**: No. 1, 10-13(7 Jan 1980).

A peak in the pK$^-\pi^+$ and p-barK$^+\pi^-$ invariant-mass spectra at 2.285 +- 0.006 GeV/c^2 is observed, which is associated with the lowest-lying charmed baryon (Λ/sub c/). A cross section times branching ratio of 0.037 +- 0.012 nb at E/sub c.m./=5.2 GeV is measured with a substantial fraction of the events produced with an equal recoiling mass. New measurements of inclusive p and Λ cross sections are also presented, allowing an estimate of the branching ratio B (Λ/sub c/ → pK$^-\pi^+$) =0.022 +- 0.010.

10759 **High-energy photoproduction of rho' (1600).** Atiya, M.S.; Holmes, S.D.; Knapp, B.C.; Lee, W.; Seto, R.; Wisniewski, W.J.; Avery, P.; Butler, J.; Gladding, G.; Goodman, M.C.; O'Halloran, T.; Russell, J.J.; Wattenberg, A.; Wiss, J.; Binkley, M.; Cumulat, J.P.; Gaines, I.; Gormley, M.; Loveless, R.L.; Peoples, J. (Columbia University, New York, New York 10027). *Phys. Rev. Lett.;* **43**: No. 23, 1691-1694(3 Dec 1979).

We observe a resonance in the diffractively photoproduced two pion final state with a mass of ~ 1600 MeV and a width of ~ 300 MeV. The four pion distribution is characterized by a width of ~ 600 MeV and peaks around 1500 MeV.

10760 **Measurement of ω-meson photoproduction on protons from 46 to 180 GeV.** Egloff, R.M.; Davis, P.J.; Luste, G.J.; Martin, J.F.; Prentice, J.D.; Caldwell, D.O.; Cumalat, J.P.; Eisner, A.M.; Lu, A.; Morrison, R.J.; Yellin, S.J.; Nash, T. (University of Toronto, Toronto, Ontario M5S 1A7, Canada). *Phys. Rev. Lett.;* **43**: No. 21, 1545-1548(19 Nov 1979).

Elastic ω-meson photoproduction on protons has been measured from 46 to 180 GeV. The cross section is approximately constant with photon energy and averages 1.10 +- 0.08 μb. The t dependence of the differential cross section is consistent with A exp(bt), where b=8.4 +- 0.7 GeV^{-2}. The photon-omega coupling constant, obtained from a normalization of hadron elastic-scattering cross sections to the photoproduction data of this experiment (with use of the vector-meson dominance and an additive quark model), is γ/sub ω/ $^2/4\pi$=5.4 +- 0.4.

WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 10467, 10757

10761 (UH—511-364-79) **High energy physics with DUMAND.** Stenger, V.J. (Hawaii Univ., Honolulu (USA). Dept. of Physics and Astronomy). 7 Nov 1979. Contract EY-76-C-03-0511. 7p. (CONF-790899—1). Dep. NTIS, PC A02/MF A01.

From 14. Pacific science congress; Khabarovsk, USSR (Aug 1979).

Neutrino interactions have proved to be a major source of fundamental information. DUMAND is the only experiment currently conceived which will be able to study neutrino interactions at TeV energies. A survey is made of some of the high energy neutrino physics experiments which have been proposed for DUMAND. Event rates are estimated for the standard 1 km^3 optical array. It is shown that W-bosons with masses up to 160 GeV are detectable. The possibilities of heavy quark production, the search for lepto-quarks, and other problems are discussed. 8 references.

10762 **Studies in the BNL 21-GeV/c negative-hyperon beam. I. Σ and Ξ production and asymmetry in the decay $\Xi^- \rightarrow \Lambda\pi^-$.** Cleland, W.E.; Cooper, W.E.; Dris, M.; Engels, E. Jr.; Herbert, M.L.; Kraus, D.E.; Thompson, J.A.; Lowenstein, D. (University of Pittsburgh, Pittsburgh, Pennsylvania 15260). *Phys. Rev., D;* **21**: No. 1, 12-24(1 Jan 1980).

In the Brookhaven National Laboratory 20.8-GeV/c negative-hyperon beam, we have measured the production ratios Σ^-/π^-, Ξ^-/π^-, and Σ^-/Ξ^- by 29.4-GeV/c protons incident on Al and Al_2O_3 targets. We have also measured the asymmetry parameter in the decay $\Xi^- \rightarrow \Lambda\pi^-$ and find α/sub Ξ/-=-0.49 +- 0.04.

10763 **Studies in the BNL 21-GeV/c negative-hyperon beam. II. Leptonic decays of Ξ and Σ.** Thompson, J.A.; Cleland, W.E.; Cooper, W.E.; Dris, M.; Engles, E. Jr.; Herbert, M.L.; Kraus, D.E.; Lowenstein, D. (University of Pittsburgh, Pittsburgh, Pennsylvania 15260). *Phys. Rev., D;* **21**: No. 1, 25-44(1 Jan 1980).

The decays $\Sigma^- \rightarrow \Lambda e^-\nu$ and $\Xi^- \rightarrow \Lambda e^-\nu$ are studied in a counter—spark-chamber experiment using unpolarized hyperons from the BNL hyperon beam. A threshold Cerenkov counter identifies the electron. From a sample of 119 reconstructed $\Sigma^- \rightarrow \Lambda e^-\nu$ events (including ~ 5 background events), we find $(\Sigma^- \rightarrow \Lambda e^-\nu)/(\Sigma^- \rightarrow n\pi^-)$ = (0.63 +- 0.10) x 10^{-4} and g/sub V//g/sub A/=-0.32 +- 0.30, g/sub W/M=-0.6 +- 3.6 (with sign convention of the Particle Data Group tables). We find Im(g/sub V//g/sub A/) =0.2 +- 0.7, consistent with time-reversal invariance. From a sample of 14 $\Xi^- \rightarrow \Lambda e^-\nu$ events (including ≅ 3.4 background events) we find $(\Xi^- \rightarrow \Lambda e^-\nu)/(\Xi^- \rightarrow \Lambda\pi^-$ = (0.30 +- 0.14) x 10^{-3}. We also searched for $\Xi^- \rightarrow \Lambda\mu\nu$ and $\Xi^- \rightarrow \Sigma^0 e\nu$ and set upper limits on these decays from our data.

10764 x dependence of the proton structure functions from inelastic antineutrino-proton scattering. Fernandez, E.; Barnes, V.E.; Carman, T.S.; Carmony, D.D.; Davis, C.L.; Garfinkel, A.F.; Laasanen, A.T.; Derrick, M.; Gregory, P.; Lopinto, F.; Musgrave, B.; Schlereth, J.; Schreiner, P.; Singer, R.; Barish, S.J.; Brock, R.; Engler, A.; Kikuchi, T.; Kraemer, R.W.; Messing, F.; Stacey, B.J.; Tabak, M. (Purdue University, West Lafayette, Indiana 47907). *Phys. Rev. Lett.;* **43**: No. 27, 1975-1979(31 Dec 1979).

From an analysis of 2275 nu-barp $\rightarrow \mu^+ + X^0$ events at an average Q^2 of 4.5 GeV^2, there are presented the first measurements, up to one undetermined overall normalization constant, of the x dependence of the proton structure functions using antineutrinos, and of the u and d-bar+s-bar quark distributions. Our result for u (x) is in good agreement with models based on fits to electron and muon scattering data. With u (x) normalized to those models the absolute antiquark momentum distribution x[d-bar (x)+s-bar (x)] in the proton is determined.

10765 Multimuon final states in muon-nucleon scattering at 270 GeV. Bauer, D.; Kiley, J.; Ball, R.; Chang, C.; Chen, K.W.; Ghods, M.; Hansen, S.; Kotlewski, A.; Litt, L.; Schewe, P.F.; Van Ginneken, A. (Michigan State University, East Lansing, Michigan 48824). E(11-1)-1764. *Phys. Rev. Lett.;* **43**: No. 21, 1551-1555(19 Nov 1979).

Data from a new muon-nucleon scattering experiment includes 513 events, of which 449 are dimuons and 64 are trimuons. Conventional hadronic and electromagnetic processes account for less than 15% of these events. Model calculations suggest that the majority of the dimuons result from associated charm production with a total cross section of about 3 nb.

10766 Measurement of the branching fraction of tau $\rightarrow$ rhov. Abrams, G.S.; Alam, M.S.; Blocker, C.A.; Boyarski, A.M.; Breidenbach, M.; Burke, D.L.; Carithers, W.C.; Chinowsky, W.; Coles, M.W.; Cooper, S.; Couchman, B.; Dieterle, W.E.; Dillon, J.B.; Dorenbosch, J.; Dorfan, J.M.; Eaton, M.W.; Feldman, G.J.; Fischer, H.G.; Franklin, M.E.B.; Gidal, G.; Goldhaber, G.; Hanson, G.; Hayes, K.G.; Himel, T.; Hitlin, D.G.; Hollebeek, R.J.; Innes, W.R.; Jaros, J.A.; Jenni, P.; Johnson, A.D.; Kadyk, J.A.; Lankford, A.J.; Larsen, R.R.; Luth, V.; Martin, J.F.; Millikan, R.E.; Nelson, M.E.; Pang, C.Y.; Patrick, J.F.; Perl, M.L.; Richter, B.; Scharre, D.L.; Schindler, R.H.; Schwitters, R.F.; Shannon, S.R.; Siegrist, J.L.; Strait, J.; Taureg, H.; Tonutti, M.; Trilling, G.H.; Vella, E.N.; Vidal, R.A.; Videau, I.; Weiss, J.M.; Zaccone, H. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76 SFOO 515;W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 21, 1555-1558(19 Nov 1979).

This Letter presents a measurement of the decay tau$^-$ $\rightarrow$ rho$^-$ ν/sub tau/ using data obtained with the Mark II detector at SPEAR. In the center-of-mass energy region 4.5 < or = E/sub c/./ sub m/. < or = 6.0 GeV 85 events are observed in which a charged rho was found in coincidence with either an electron or a muon. It was determined that B (tau$^-$ $\rightarrow$ rho$^-$ ν/sub tau/) = (20.5 +- 4.1) % and the ratio B (tau$^-$ $\rightarrow$ rho$^-$ ν/sub tau/)/B (tau$^-$ $\rightarrow$ e$^-$ ν/sub tau/nu-bar/sub e/) = 1.11 +- 0.23.

10767 Muon pair production in 16 and 22 GeV π^- Cu collisions. Alspector, J.; Borenstein, S.; Strand, R.C.; Kalbfleisch, G.R.; Abashian, A.; LeBritton, J.; McCal, D.; Melissinos, A.C.; Metcalf, W. (Brookhaven National Lab., Upton, NY (USA)). *Phys. Lett., B;* **81**: No. 3-4, 397-400(26 Feb 1979).

The authors have measured inclusive muon pair production by 16 and 22 GeV π^- on a copper target in a wide aperture magnetic spectrometer. The data are interpreted in terms of quark annihilation models and approximate scaling in the variable tau = M^2/s is found over a wide energy range. At large values of tau the yield of μ-pairs produced by π^- is approximately 100 times that produced by protons. This effect can be understood by assuming appropriate quark distributions for π^- and p and thus provides experimental insight into the inner structure of these particles.

STRONG BARYON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 10467, 10762, 10778, 10783, 10784

10768 (LA—8059-T) **Analyzing power and differential cross section for pion-deuteron production by 0.8-GeV polarized protons on hydrogen.** Joseph, R.J. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 105p. Dep. NTIS, PC A06/MF A01.

Thesis. Submitted to Univ. of Texas, Austin.

A 0.8-GeV polarized proton beam was used to measure the analyzing power and unpolarized differential cross section for the reaction pp $\rightarrow$ dπ^+. Eight multiwire proportional counters were used in a two-arm system to detect both the deuteron and pion for left-right scattering. Reversal of the beam polarization every three minutes and use of the two-arm system removed systematic errors from the analyzing power measurement. A fit of the analyzing power to a phenomenological model indicates the importance of d- and f-wave pions at this energy. The unpolarized cross-section data does not support d-wave pions. This underlines the sensitivity of the analyzing power to different pion partial waves.

10769 Measurement of p-barp backward elastic-scattering cross section from 406 to 922 MeV/c. Alston-Garnjost, M.; Hamilton, R.P.; Kenney, R.W.; Pollard, D.L.; Tripp, R.D.; Nicholson, H.; Lazarus, D.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48;ER-78-S-02-4831;EY-76-C-02-0016. *Phys. Rev. Lett.;* **43**: No. 26, 1901-1904(24 Dec 1979).

The cross section for 180° elastic scattering of antiprotons by protons between 406 and 922 MeV/c has been measured. A single-arm spectrometer detected recoil protons corresponding to events with <cosθ/sub c.m./> =-0.994. The regions of the reported resonances at 1936 MeV and 2020 MeV were scanned in 10-MeV/c steps with a typical statistical error of $\simeq$ 7% and an rms mass resolution of +- 3 MeV. No narrow enhancements (Γ < 10 MeV) were observed.

10770 Measurement of Λ^0 polarization in inclusive Λ^0 production at 28.5 GeV/c. Lomanno, F.; Jensen, D.; Kreisler, M.N.; Poster, R.; Rabin, M.S.Z.; Way, M.; Wise, J.; Humphrey, J. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003). *Phys. Rev. Lett.;* **43**: No. 26, 1905-1908(24 Dec 1979).

Λ^0 polarization in inclusive production by protons on iridium has been measured at 28.5 GeV/c over the region 0.55 GeV/c < or = P/sub perpendicular/ < or = 1.6 GeV/c. The polarization rises from (-12.6 +- 5.5) % at 0.55 GeV/c to (-33.4 +- 4.6) % at 1.6 GeV/c. Significant differences from previous measurements at other energies with different targets are observed, particularly at low P/sub perpendicular/.

10771 Observation of missing energy associated with $\mu^+\mu^-$ produced in p-Fe interactions. Diamant-Berger, A.; Dishaw, J.P.; Faessler, M.; Liu, J.K.; Merritt, F.S.; Wojcicki, S.G.; Barish, B.C.; Bartlett, J.F.; Bodek, A.; Merritt, K.W.B.; Shaevitz, M.H.; Siskind, E.J. (Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **43**: No. 24, 1774-1777(10 Dec 1979).

In a study of interactions of 400-GeV protons in an iron calorimeter, we have observed $\mu^+\mu^-$ pairs associated with a significant amount of missing energy indicative of final-state neutrinos. This missing energy is not due to any instrumental effects, nor to any trivial sources like double KK-bar (or $\pi\pi$) decay. Interpretation of these data as production of a DD-bar pair followed by a double muonic decay leads to a model-dependent estimate of a total production cross section of the order of 7—20 μb.

10772 Light hadronic spectroscopy: Experimental and quark model interpretations. Protopopescu, S.D.; Samios, N.P. (Brookhaven National Laboratory, Upton, New York 11973). EY-75-C-02-0016. *Annu. Rev. Nucl. Sci.;* **29**: No. 1, 339-393(Dec 1979).

Meson resonance mass spectra and quasi two-body decays are summarized as are baryon resonance phase shift. (AIP)

10773 Analyzing power for the reaction up arrow pp $\rightarrow$ dπ at 0.8 GeV proton energy. Cverna, F. (Los Alamos Scientific Lab., NM); McNaughton, M.; Hwang, C.; Bonner, B.; King, N.; Willard, H.; Winkleman, E.; Joseph, R. pp 64 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A 0.8-GeV polarized proton beam was used to measure the analyzing power for the reaction pp $\rightarrow$ dπ^+. The importance of d-wave pions is found. (JFP)

10774 Δi production in the reaction pp $\rightarrow$ ppπ^0 at 800 MeV. Pepin, G.P. (Rice Univ., Houston, TX); Mutchler, G.S.; Furic, M. pp 69-70 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The Δ^+ production in the reaction pp $\rightarrow$ ppπ^0 was studied in a kinematically complete experiment. Preliminary cross sections are shown as a function of proton momentum. The peak in the cross section at about 900 MeV/c corresponds to the Δ^+. 1 reference. (JFP)

10775 Overview of absorption and production of mesons. Koltun, D.S. (Univ. of Rochester, NY). pp 87-94 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A brief look at some of the recent developments in experiment and theory of meson absorption and production is given. It is attempted to show that a number of advances were made in under-

standing the connection of absorption, inelastic scattering, and the optical model. 17 references. (JFP)

10776 Negative pion absorption and isobar formation as observed in the streamer chamber particle nuclei interactions. Allen, R.; Kanofsky, A.; Hasan, A. (Lehigh Univ., Bethlehem, PA). pp 197-198 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Negative pion interactions with nuclei as observed in a helium- and neon-filled streamer chamber with isobar production was observed. The angular and negative momentum distributions are discussed. Negative pion production just from incident positive pions and protons is investigated as well. (JFP)

10777 Study of the two nucleon mechanism for pion production. Giebink, D.R. (Los Alamos Scientific Lab., NM); Gibbs, W.R.; Siciliano, E.R. pp 205 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The one-pion exchange approximation in the reaction $p + p \rightarrow p + n + \pi^+$ is studied using the relativistic three-body helicity formalism of Wick. This formalism allows for a correct relativistic treatment while admitting the freedom to systematically address some questions that are investigated by considering their contribution to the pion asymmetry and differential cross section in the studied reaction. Among these questions are the relation between the off shell πN scattering amplitude in the two-body center of mass and that amplitude in the many body center of mass, the effect of using different off-shell prescriptions for the πN vertex, the importance of s- and small p-wave contributions, and the effect of removing the nucleon pole terms from the πN scattering amplitude. 2 references. (JFP)

STRONG MESON-INDUCED INTERACTIONS

REFER ALSO TO CITATION(S) 10755, 10772, 10776, 10837

10778 (ANL-HEP-CP—79-36) **Particle production by neutrinos.** Schreiner, P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 13p. (CONF-790885—6). Dep. NTIS, PC A02/MF A01.

From 9. international symposium on lepton and photon interactions at high energy; Batavia, IL, USA (23 Aug 1979).

A review is given of particle production by neutrinos in charged-current inclusive and exclusive channels. The production rates for various particles in neutrino-nucleon interactions at a beam energy of 25 GeV are compared. The mesons are, of course, dominated by pion production. The $\rho^0(760)$ rate is an order of magnitude smaller. Strange and charm pseudoscalar mesons are a further factor of two down in rate. The strange vector mesons are suppressed by more than an order of magnitude relative to K^0 production; however, the charmed $D^{*+}(2010)$ is only a factor of two smaller in rate than the $D^0(1860)$. With regards to the baryons, most of them are, of course, nucleons. The Λ^0 and $\Sigma^*(1385)$ rates are down by one and two orders of magnitudes, respectively. The lower limit on the charmed Σ/sub c/$^{++}$ baryon rate is similar to the $\Sigma^*(1385)$ rate. Finally, the quasielastic and one-pion production exclusive channels have about the same cross section as that of the D^{*+}; associated production of strange particles in the $\nu n \rightarrow \mu^- K^+ \Lambda$ channel and the $\Delta S = +\Delta Q$ process $\nu p \rightarrow \mu^- p K^+$ are down by factors of five and twenty, respectively, compared to the quasielastic cross section.

10779 (COO—3064-035) **Initial studies of the charmonium system using the Crystal Ball data at SPEAR.** Bloom, E.D. (Stanford Linear Accelerator Center, CA (USA)). 14 Jun 1979. Contract EY-76-C-02-3064. 33p. (CONF-790365—10). Dep. NTIS, PC A02/MF A01.

From 16. rencontre de moriond; Les Arcs, Savoie, France (17 Mar 1979).

First results from the Crystal Ball experiment (SP-24) are presented. In particular a preliminary analysis of 800K events at the J/psi(3095) and 190K events at the psi'(3684) gives new information on the existence of controversial states of the charmonium system. No signal is found for the X(2820). 17 references.

10780 Measurement of π^{+-}p backward elastic scattering between 30 and 90 GeV/c. Baker, W.F.; Eartly, D.P.; Kalbach, R.M.; Klinger, J.S.; Lennox, A.J.; Polakos, P.A.; Pifer, A.E.; Rubinstein, R. (University of Arizona, Tucson, Arizona 85721). *Phys. Rev. Lett.;* **43**: No. 22, 1635-1638(26 Nov 1979).

Measurements of π^{+-}p backward elastic scattering have been made for incident pion momenta between 30 and 90 GeV/c and for $0 < -u < 0.5$ $(GeV/c)^2$. The momentum dependence of the cross sections is of a form expected from a simple Regge model, and the u-dependence of the cross sections is similar to that observed at lower momenta.

10781 Accurate measurements ofπ^+- + proton elastic scattering at LAMPF. Sadler, M.E.; Arman, M.; Borcherding, F.; Briscoe, W.J.; Fitzgerald, D.H.; Glodis, P.F.; Haddock, R.P.; Matz, N.; Nefkens, B.M.K.; Seftor, C.; Silverman, B. (Univ. of California, Los Angeles). pp 54 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Differential cross section measurements of $\pi^+ + p$ elastic scattering at 378 to 625 MeV/c are now being completed. Preliminary results were obtained for a liquid hydrogen target and are shown for 427 MeV/c. 5 references. (JFP)

10782 Low energy π^+p and π-p elastic scattering. Frank, J.S.; Browman, A.A.; Gram, P.A.M.; Mischke, R.E.; Nagle, D.E.; Potter, J.M.; Redwine, R.P.; Yates-Williams, M.A. (Los Alamos Scientific Lab., NM). pp 55-56 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The differential cross sections were measured for both π^+p and π-p elastic scattering at pion kinetic energies of 29.1 to 89.4 MeV. Preliminary data are shown. 3 references. (JFP)

10783 Observation of Frankel effect events in particle nuclei collisions in a streamer chamber. Allen, R.; Kanofsky, A.; Hasan, A. (Lehigh Univ., Bethlehem, PA). pp 199-200 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A Frankel event is here defined as one where the leading particle momentum, as measured by the track curvature is not more than 300 MeV/c below incoming beam momentum. Thus it is assured that the inelasticity of the event is not greater than about 300 MeV. The fraction and multiplicity of Frankel events are shown for the various beam and target conditions including the distribution for He and Ne obtained in polar angle and momentum magnitude for the k vectors as well as the distribution of the momentum magnitudes for proton and pion reactions. 3 references. (JFP)

10784 Particle multiplicity correlations observed in particle nuclei collisions. Allen, R.; Kanofsky, A.; Hasan, A. (Lehigh Univ., Bethlehem, PA). pp 201-202 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Results are given on particle total multiplicities and multiplicity correlations on an event by event basis as observed in a streamer chamber. From this it was possible to see all minimum ionizing tracks and fragments resulting from collisions of pions and protons with He and Ne nuclei. (JFP)

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

REFER ALSO TO CITATION(S) 10814, 10822, 10824, 10827, 10940

10785 Constructive evidence for flavor independence of the quark-antiquark potential. Quigg, C.; Thacker, H.B.; Rosner, J.L. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **21**: No. 1, 234-240(1 Jan 1980).

The masses and leptonic widths of vector mesons may be used to construct quark-antiquark potentials by means of an inverse-scattering method. This technique has been applied to the charmonium system. A corresponding potential has been constructed from Y and Y' and found to be in substantial agreement with that constructed from psi and psi' if the Y is composed of a charge -1/3 quark and the corresponding antiquark. This agreement may be interpreted as evidence for flavor independence of the quark-antiquark potential. Predictions for a hypothetical zeta family of higher-lying vector mesons also are noted.

10786 Asymptotic freedom in deep inelastic processes in the leading order and beyond. Buras, A.J. (Fermi National Accelerator Laboratory P.O. Box 500, Batavia, Illinois 60510 USA). *Rev. Mod. Phys.;* **52**: No. 1, 199-276(Jan 1980).

The present status of quantum chromodynamics formalism for inclusive deep-inelastic scattering is reviewed. Leading-order and

higher-order asymptotic freedom corrections are discussed in detail. Both the formal language of operator product expansion and renormalization group and the intuitive parton model picture are used. Systematic comparison of asymptotic freedom predictions with deep-inelastic data is presented. Extensions of asymptotic freedom ideas to other processes such as massive μ-pair production, semi-inclusive deep-inelastic scattering, e^+e^- annihilation, and photon—photon scattering are briefly discussed. The importance of higher-order corrections is emphasized.

10787 Renormalization of the broken-symmetry two-dimensional SU(N) σ model and (psi barpsi)^2 model. Cooper, F.; Guralnik, G.; Haymaker, R.W.; Tamvakis, K. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **20**: No. 12, 3336-3357(15 Dec 1979).

We derive the renormalized Schwinger-Dyson equations for the two-dimensional SU(N) σ model with N psi/sub i/ and one σ and the (psi-bar/sup i/psi/sup i/)^2 model with spontaneously broken symmetry $<\sigma>$ not = 0. We study the σ model in the composite limit when the σ wave-function renormalization constant Z_3 and the 4-σ vertex renormalization constant Z_4 are zero and find that the renormalized Green's functions of the σ model become identical to those of the (psi-barpsi)^2 model. In the composite limit of the σ model the renormalized coupling constants gpsi-barpsiσ and λ/sub 4sigma/ are related and oecome calculable in terms of the spontaneously generated fermion mass. We obtain the renormalized gap equation for M/sub sigma/ $^2<\sigma$/sub r/> which determines the minimum of the effective potential and discuss the Callan-Symanzik equations for the broken-symmetry sector of these models. We show that the $Z_3=Z_4=0$ limit of the σ model is obtained at the fixed point $\beta=0$ of the Callan-Symanzik equations.

10788 Grand unified theory with heavy color. Farhi, E.; Susskind, L. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **20**: No. 12, 3404-3411(15 Dec 1979).

An example of the unification of electroweak, color, and heavy-color forces in the unifying group SU(7) is presented. This simple toy model predicts a nontrivial mass spectrum for two families of quarks and leptons. The usual Higgs scalar sector is replaced by the strong interaction heavy-color sector at $\sim$1 TeV.

10789 Operator analysis of nucleon decay. Wilczek, F.; Zee, A. (Department of Physics, Princeton University, Princeton, New Jersey 08544). EY-76-C02-3072;AT(E11-1)3071. *Phys. Rev. Lett.;* **43**: No. 21, 1571-1573(19 Nov 1979).

The operator structure of the effective Hamiltonian mediating nucleon decay is analyzed. Selection rules diagnostic of the underlying superunified theories are derived. A kinship hypothesis important in analyzing nucleon decay is formulated and tests of it are proposed.

ELECTROMAGNETIC INTERACTIONS

REFER ALSO TO CITATION(S) 10796, 10803, 10829

10790 Jet angular distribution from quantum chromodynamics. Nandi, S.; Wada, W.W. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., D;* **21**: No. 1, 76-81(1 Jan 1980).

We calculate the quantum-chromodynamic correction to the jet (defined in the manner of Sterman and Weinberg) angular distribution in energetic e^+e^- annihilation to order α/sub s/ keeping exact dependence on ϵ and δ. We find deviations from the zeroth-order distribution, $1+\cos^2\theta$, for relatively large values of ϵ and δ. This effect could be tested at the existing e^+e^- colliding-beam facilities.

10791 Jets in photon collisions and tests for a pointlike coupling of the photon. Soni, A. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **43**: No. 26, 1908-1911(24 Dec 1979).

The pointlike coupling of the photon to the quark current yields simple predictions for the leading fast mesons in high-p/sub t/ γN (lN), e^+e^-, and $\gamma\gamma$ reactions, e.g., for $\gamma p \to hX$ one gets $K^+:K^-:K^0$:K-bar^0 = 8:0:1:0 and $\pi^+:\pi^-:\pi^0$ = 8:1:9/2. It is noted that in γN collisions the dominant jet cross section arises from the hard subprocess: γ + gluon $\to$ q + q-bar. This may yield the gluon distribution via s $s_0(d\sigma/ds_0)$ K^{-1} = f/sub g/(x) and lead to a sum rule: $\int s_0$ $^2(d\sigma/ds_0)$ ds_0/sK = phixf/sub g/(x) dx, where K = $4\pi\alpha a$/sub s/ln(s/ 2p/sub t/min ^{2}).

10792 Quark color magnetic moment. Sapirstein, J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **20**: No. 12, 3246-3252(15 Dec 1979).

The quark color magnetic moment is examined in the framework of the interaction of a quark with a constant external color magnetic field. Quark and gluon propagators in the external field are evaluated and shown to lead to a field-dependent anomalous magnetic moment $\mu = (gh/2mc)(3\alpha$/sub s/$/4\pi)\ \ln(gB/m^2)$, where B is the external field strength. Comparison is made with the behavior of the electron anomalous magnetic moment in strong fields. Possible phenomenological consequences for hadron mass splittings are discussed.

WEAK INTERACTIONS

10793 (SLAC-PUB—2402) Massive lepton pair production. Stroynowski, R. (Stanford Linear Accelerator Center, CA (USA)). Sep 1979. Contract EY-76-C-03-0515. 62p. (CONF-790774—2). Dep. NTIS, PC A04/MF A01.

From SLAC summer institute on particle physics: quantum chromodynamics; Stanford, CA, USA (9 Jul 1979).

In this review of massive lepton pair production the Drell-Yan mechanism is defined in terms of the parton model, and the modifications expected from Quantum Chromodynamics description of the process are described. The problems of the phenomenology of the data are described. Included in addition are particle-type dependence, mass spectra, momentum spectra of lepton pairs, Quantum Chromodynamics phenomenology of lepton pair production, angular distributions, structure functions and quark distributions, and the future outlook. 40 references. (JFP)

10794 Remarks on the differing lifetimes of charmed mesons. Rosen, S.P. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **44**: No. 1, 4-7(7 Jan 1980).

Differences in the D^+ and D^0 lifetimes may arise either from 6 dominance in the effective nonleptonic Hamiltonian, or from the dominance of a particular W^+-exchange diagram which behaves like a D^0-K-bar^{0*} pole. If 6 dominance holds, then the F^+ will have a relatively short lifetime and a small semileptonic branching ratio, just like the D^0; but if W^+ exchange is dominant, the F^+ will have a long lifetime and large semileptonic branching ratio, like the D^+.

10795 Parity nonconservation in e-N interactions in a left-right-symmetric gauge model. Sidhu, D.P.; Tudron, T.N. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Phys. Rev., D;* **21**: No. 1, 45-53(1 Jan 1980).

We give a detailed discussion of parity nonconservation in e-N interactions in an SU(2)/sub L/ x SU(2)/sub R/ x U(1) gauge model discussed recently by one of us. The predictions of the model are compared with the results of the atomic parity violation and polarized-electron—deuteron scattering experiments. Also given are estimates of the leptonic and hadronic decay widths of the two Z bosons of the model.

10796 Parity-violating asymmetries in dilepton production by polarized protons. Gilman, F.J.; Tsao, T. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). DE-AC03-76SF00515. *Phys. Rev., D;* **21**: No. 1, 159-164(1 Jan 1980).

The parity-violating asymmetries arising from weak-electromagnetic interference in production of dileptons by polarized protons are investigated. The two separate terms in the asymmetry are calculated within the Weinberg-Salam model and the implications for experiment are discussed.

10797 Current-algebra predictions for D $\to$ Kπlν decay. Rolnick, W.B.; Stowe, K. (Department of Physics, Wayne State University, Detroit, Michigan 48202). EY-76-C-02-1112;EY-76-S-02-2302. *Phys. Rev., D;* **21**: No. 1, 165-173(1 Jan 1980).

We apply current-algebra techniques to D $\to$ Kπlν decay to obtain their predictions in the soft-pion and soft-kaon limits. We then extend these techniques to the region where the kaon and pion momenta are small but finite to obtain predictions for the form factors and the decay distributions in this region.

10798 Current-algebra analysis of CP violations in K $\to$ 3π decayin the six-quark Weinberg-Salam model. Li, L.; Wolfenstein, L. (Physics Department, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). W-7405-ENG-48;EY-76-02-3066. *Phys. Rev., D;* **21**: No. 1, 178-181(1 Jan 1980).

The standard current-algebra technique is used to relate the parameter eta/sub +/-0 equivalent $< \pi^+\pi^-\pi^0$ vertical-bar H/sub w/ vertical-bar K/sub S/ $> / < \pi^+\pi^-\pi^0$ vertical-bar H/sub w/ vertical-bar K/sub L/ > in K $\to$ 3π decay to the CP-violating parameters of K $\to$ 2π decays in the context of the six-quark Weinberg-Salam theory (Kobayashi-Maskawa model).

10799 Weak $\Delta I = 1/2$ rule and the dynamical Higgs mechanism. Carter, A.; Pagels, H. (Rockefeller University, New York, New York 10021). EY-76-C-02-2232B. *Phys. Rev. Lett.;* **43**: No. 25, 1845-1847(17 Dec 1979).

We show that the weak $\Delta I = 1/2$ rule, m/sub W/ ^{3}/m/sub Z/ $^2 = \cos^2\theta$, in an SU/sub L/(2) x U(1) gauge model can be obtained from a dynamical Higgs mechanism. This is independent of weak isospin breaking in the fermion mass spectrum. A consequence of this mechanism is a sum rule which implies the existence of heavy quarks or leptons with ultraviolet masses comparable to the W and Z weak boson masses, $\sim$ 30—100 GeV.

10800 Experimental characteristics of dynamical pseudo-Goldstone bosons. Beg, M.A.B.; Politzer, H.D.; Ramond, P. (The Rockefeller University, New York, New York 10021). EY-76-C-02-2232B;DE-AC-79-ER0068. *Phys. Rev. Lett.;* **43**: No. 23, 1701-1704(3 Dec 1979).

The hypothetical existence of new color interactions, which participate in the spontaneous breaking of the weak interaction group, will in general lead to relatively light composite pseudo-Goldstone bosons. Their production and decay characteristics are analyzed to be close to, yet actually distinguishable from, those of the elementary Higgs bosons of the Weinberg-Salam model.

10801 Parity violating asymmetries in polarized electron scattering. Derman, E.; Marciano, W.J. (The Rockefeller University, New York, New York 10021). EY-76-C-02-2232B.000. *Ann. Phys. (N.Y.);* **121**: No. 1, 147-180(1 Sep 1979).

We discuss parity violating asymmetries between the scattering of right and left-handed electrons on a variety of targets. Implications for gauge theories from recent SLAC results on deep-inelastic electron-deuterium and electron-proton scattering are examined. A derivation of the asymmetry for electron-electron scattering is given, its advantages are pointed out, and the feasibility of such a measurement is discussed. Other proposed or contemplated asymmetry experiments are reviewed and the necessity of including the Collins-Wilczek-Zee hadronic axial isoscalar current contribution in asymmetry predictions is noted.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 10772, 10818, 10888

10802 (COO—1545-265) **Mixing angles in SU(2)/sub L/ x U(1) gauge model.** Nandi, S.; Tanaka, K. (Ohio State Univ., Columbus (USA). Dept. of Physics). 1979. Contract EY-76-C-02-1545. 4p. Dep. NTIS, PC A02/MF A01.

Exact expressions for the mixing parameters are obtained in terms of mass ratios in the standard Weinberg-Salam model with permutation symmetry S_3 for six quarks. The CP-violating phase is ignored, and there are no arbitrary parameters except for the quark masses. In the lowest order, the angles defined by Kobayashi-Maskawa are sin θ/sub 1/ = sin θ/sub c/ = (m/sub d//m/sub d/ + m/sub s/)/sup 1/2/, sin θ_3 = -sin θ/sub 3/ = -m²/sub s//m²/sub b/, and m/sub t/m/sub s/ ≧ m/sub c/m/sub b/ = 7.2 GeV² or m/sub t/ ≧ 24 GeV for m/sub s/ = 0.3 GeV.

10803 Basic processes and formalism for the hadronic production of three large-p/sub T/ jets. Gottschalk, T.; Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **21**: No. 1, 102-130(1 Jan 1980).

We evaluate those processes in perturbative quantum chromodynamics which can lead to the production of three high-p/sub T/ jets in hadron-hadron collisions. A formalism is proposed which incorporates event vetos to separate hard-scattering jets from spectator jets. These vetos modify the scaling violations of the initial parton distribution functions. A simple estimate indicates that the three-jet fraction in high-p/sub T/ hadron processes may be up to four times larger than the corresponding three-jet fraction in e^+e^- annihilation.

STRONG INTERACTIONS, BARYON NO.=0

REFER ALSO TO CITATION(S) 10841, 10910

10804 Study of prompt e^+e^-, eta^0, and ω^0 production in low-energy p-barp annihilations. Levman, G.; Singer, R.; Fields, T. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **21**: No. 1, 1-9(1 Jan 1980).

A study of prompt e^+e^- production has been made using the Argonne 12-foot bubble chamber exposed to a low-energy p-bar beam. We found eleven annihilation events with e^+e^- pairs of invariant mass greater than the π^0 mass. The background to direct e^+e^- pair production comes mainly from eta$^0 \rightarrow \gamma e^+e^-$ and $\omega^0 \rightarrow \pi^0 e^+e^-$ Dalitz pairs. To determine these backgrounds, we have measured the inclusive eta^0 and ω^0 production rates using externally converted γ rays. We find $\omega^0/\pi^0 = 0.20 \pm 0.07$ and eta$^0/\pi^0 < 0.11$ at the 90% confidence level. The (eta^0 + ω^0) Dalitz background plus other small backgrounds yield 7.0/sup +4.4//sub -3.0/ events. The remaining events yield a 90%-confidence-level upper limit for the ratio of prompt e^+e^- pairs to π^0 production of 4×10^{-5}.

10805 Interaction of nucleons with antinucleons I. General features of the NN spectrum in potential models. Buck, W.W.; Dover, C.B.; Richard, J.M. (Department of Physics, State University of New York, Stony Brook, New York 11794). (11.1)-3001; EY-76-C-020016. *Ann. Phys. (N.Y.);* **121**: No. 1, 47-69(1 Sep 1979).

We discuss the general features of the spectrum of antinucleon-nucleon (NN) bound states and resonances, using real potentials obtained via G-parity transformation from several realistic NN models. The main properties of the NN level ordering emerge from a model independent study of the coherences of meson exchange forces, which are complementary to those characterizing the NN system. However, the absolute energies of NN states, and the level density near threshold are very model dependent.

10806 Interaction of nucleons with antinucleons II. Narrow mesons near threshold—experiments and theory. Dover, C.B.; Richard, J.M. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Ann. Phys. (N.Y.);* **121**: No. 1, 70-112(1 Sep 1979).

We compare and contrast several theoretical approaches which could account for a new class of narrow mesons recently observed in the mass region 1.5—3GeV/c^2, particularly those clustered near the antinucleon-nucleon (NN) threshold. We examine dual and quark models as well as NN potential models, focusing attention on differences between the quantum numbers of mesons predicted to lie near threshold. A preliminary comparison with data does not yet yield a strong preference for a particular model, although some crucial experiments are suggested. The main emphasis of this paper is on the meson spectrum predicted by N-barN potential models. In a previous work, referred to as I, we have discussed the level ordering of the spectrum for a number of realistic meson exchange models. In this sequel, we consider in more detail the candidates for narrow structures close to threshold. Estimates of the mixing of N-barN with other baryon-antibaryon configurations are given, as well as approximate values for the elastic and annihilation widths of these structures. We discuss criteria for identifying relatively pure N-barN states, as distinct from other multiquark complexes. We inquire to what extent useful constraints on the medium- and long-range nuclear forces could result from identification of an N-barN meson. Some speculations on the quantum numbers of the "new" mesons are presented.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 10910

10807 Theory of the half-shell πN t-matrix. Reiner, M.J. (Univ. of Rochester, NY). pp 57-58 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The theory of the half-shell πN t-matrix (the final pion being off its mass shell) as described previously was generalized to all partial waves in a way as to exactly maintain the crossing symmetry. Results are presented for the S and P wave states and compared to other commonly used off-shell extensions of the πN t-matrix. 2 references. (JFP)

10808 Pion-nucleon interactions in P wave. Wei, N.C. (Univ. of Maryland, College Park); Banerjee, M.K.; Cammarata, J.B. pp 80-81 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A recently developed dynamical theory of πN interactions based on the use of PCAC, the notion of σ commutator, etc., was used to calculate the P wave πN interaction. Preliminary results for the scattering volumes are presented. 5 references. (JFP)

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

10809 (CONF-7906141—1) **Nucleon-nucleon potentials and two-body Hamiltonians.** Coester, F. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From Topical meeting on the Meson Theory of Nuclear Forces; Bad Honnef, F.R. Germany (12 Jun 1979).

The physical significance of nucleon-nucleon potentials depends on their relation to the two-nucleon mass operator. These relations are examined for phenomenological potentials. Momentum space Bethe-Salpeter amplitudes with one particle on the mass shell approximate half-off-shell T matrices defined in the framework of the Haag-Ruelle theory. This implies a relation between potentials derived from a Bethe-Salpeter equation and effective two-body mass operators. 16 references.

10810 Charge-symmetry breaking in the nucleon-nucleon interaction. Langacker, P.; Sparrow, D.A. (Department of Physics, University of Pennsylvania, Philadelphia, Pennsylvania 19104). EY-76-C-02-3071. *Phys. Rev. Lett.;* **43**: No. 21, 1559-1562(19 Nov 1979).

New calculations of charge-symmetry breaking in the NN interaction lead to radically altered predictions for the difference between nn and pp scattering lengths. Inclusion of the eta' meson and use of realistic magnetic couplings for the vector meson changes

the sign as well as the magnitude of earlier results. This sensitivity arises in part from cancellations within the pseudoscalar and vector contributions separately, making precise calculations difficult. Meson mixing is determined from quark mass differences, and the finite width of the rho meson is included.

10811 Relativistic description of the electromagnetic form factor of the deuteron. Fernandez-Pacheco, A.; Grifols, J.A.; Schmidt, I. (Stanford Linear Accelerator Center, CA (USA)). *Nucl. Phys., B;* **151**: No. 3, 518-528(14 May 1979).

A covariant model of the electromagnetic form factor of the deuteron in the impulse approximation is presented. The treatment includes spin and allows for a complete determination of the two elastic structure functions. The results are in good agreement with experimental data.

10812 Pion production in PP collisions. Duck, I. (Rice Univ., Houston, TX). pp 95-106 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

An attempt is made to understand the exclusive pion production experiments in terms of the OPE and VME amplitudes. Differential and total cross sections are found. 14 references. (JFP)

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

10813 "C-P problem" in two dimensions. Fischler, W. (Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **20**: No. 12, 3399-3403(15 Dec 1979).

An analog in two dimensions to the Peccei-Quinn solution for the C-P problem is presented. This solution suffers the presence of an axion. We show how to avert unwanted light particles by following the Dimopoulos-Susskind scheme. The occurrence of a naturally small C-P violation is evaluated.

10814 SU(9) grand unification of flavor with three generations. Frampton, P.; Nandi, S. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev. Lett.;* **43**: No. 20, 1460-1462(12 Nov 1979).

A model based on the group SU(9) is proposed to relate three quark-lepton generations. There is sufficient unification to give two new relations between the nine fermion masses. The guiding principle is to minimize the number of Higgs scalars necessary to obtain mass relations.

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

REFER ALSO TO CITATION(S) 10798

10815 Calculability in SU(2)/sub L/ x SU(2)/sub R/ x U(1): The mass matrix and CP-invariance violation. Rothman, A.C.; Kang, K. (Physics Department, Brown University, Providence, Rhode Island 02912). *Phys. Rev. Lett.;* **43**: No. 21, 1548-1551(19 Nov 1979).

It is shown that calculability of the mixing angles in a class of n-generation left-right-symmetric SU(2)/sub L/ x SU(2)/sub R/ x U(1) models restricts the fermion mass matrix to be of the form Σ/sub m/=0 /sup n/ direct-sum I/sub m/A/sub m/ with the constraint Σ/sub m/=0 /sup n/mI/sub m/=n, where A/sub m/ is a nonsingular m x m Hermitian or complex symmetric block containing 2m-1 elements and I/sub m/ is the number of such blocks. Such a mass of matrix cannot supply CP-invariance-violating phases.

APPLICATIONS TO STRONG INTERACTIONS

REFER ALSO TO CITATION(S) 10810

10816 Charge-symmetry violation in the reaction np $\rightarrow$ dπ^0. Cheung, C.Y.; Henley, E.M.; Miller, G.A. (Univ. of Washington, Seattle). pp 61 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The possibility of charge-symmetry violation in the np $\rightarrow$ dπ^0 reaction as measured by the differential cross section around the (3,3) resonance is considered for several charge-symmetry breaking mechanisms, some of which are calculated. It is found that the eta-π mixing mechanism gives the greatest asymmetry. The preliminary result is that the asymmetry due to neutron-proton mass difference is about half of that due to eta-π mixing, while the Δ^+-Δ^0 mass difference is not expected to give a large effect. 1 reference. (JFP)

FIELD THEORY

REFER ALSO TO CITATION(S) 10785, 10787, 10788, 10789, 10790, 10794, 10799, 10800

10817 (ORO—3992-371) Synthesis of baryons from unconfined quarks. Dicus, D.; Pati, J.; Teplitz, V. (Texas Univ., Austin (USA). Center for Particle Theory; Maryland Univ., College Park (USA). Dept. of Physics and Astronomy; Arms Control and Disarmament Agency, Washington, DC (USA)). Sep 1979. Contract EY-76-S-05-3992. 21p. Dep. NTIS, PC A02/MF A01.

The cosmic temperature at which primordial quarks condense into baryons is calculated for a number of cases within a field theory of partially confined quarks that enjoys temporary asymptotic freedom. It is assumed that the mass of a quark in a dense quark antiquark medium is a monotonic function of the medium, that is, that the so-called Archimedes effect is valid. It is shown that, within such models, unbound quark lifetimes are larger than the age of the universe at the time of the transition and that the Archimedes effect implies that the change of the medium from free to bound quarks is a phase transition. 1 figure, 1 table.

10818 (SLAC-PUB—2436) Simple model of the ground state of quantum chromodynamics. Johnson, K. (Stanford Linear Accelerator Center, CA (USA)). 1979. Contract EY-76-C-03-0515. 12p. (CONF-7910116—2). Dep. NTIS, PC A02/MF A01.

From Annual meeting of the American Physical Society; Montreal, Canada (25 Oct 1979).

A proposal for the form of the ground-state wave function of quantum chromodynamics is made. It is shown to lead to the phenomenology of the MIT Bag Model. The parameters of this model are related to the fundamental scale parameter of QCD. 2 tables.

10819 Geometrical gauge conditions in Yang—Mills theory: Some nonexistence results. Chodos, A.; Moncrief, V. (Department of Physics, Yale University, New Haven, Connecticut 06520). *J. Math. Phys. (N.Y.);* **21**: No. 2, 364-371(Feb 1980).

We investigate the possibility of defining an "orthogonal" gauge for non-Abelian Yang—Mills theory. Such a gauge would generalize, in a geometrical way, the orthogonality features of the Coulomb gauge in electrodynamics. We show however that such a gauge does not exist (even locally) in the non-Abelian case. Specifically we prove that the tangent spaces defined at every point by orthogonality to the gauge group orbits admit no integral submanifolds. We also study the question of existence of global gauge conditions in phase space. We show that such global gauges, should they exist, would induce globally defined gauges in configuration space contradicting Singer's result. We thus conclude (modulo certain technical points which might render Singer's argument inapplicable to our function spaces) that global gauge conditions in phase space do not exist.

10820 Comments on the classical gauge field with sources. Kiskis, J. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., D;* **21**: No. 2, 421-425(15 Jan 1980).

Two results for the classical SU(2) gauge field interacting with a static external source are given: (1) The smooth solutions associated with a smooth non-Abelian source are non-Abelian. (2) The minimum-energy field configuration for a smooth source is not smooth. It exhibits a pathological property we refer to as high-wave-number screening.

10821 Stability and bifurcation in Yang-Mills theory. Jackiw, R.; Rossi, P. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). EY-76-C-02-3069. *Phys. Rev., D;* **21**: No. 2, 426-445(15 Jan 1980).

Whenever gyroscopic forces are present, stable static solutions to dynamical equations of motion need not minimize the energy. We show that this happens in the classical Yang-Mills theory with sources, and we identify the stable fluctuations which lower the energy. The finite form of these infinitesmal, time-dependent deformations of the known static solutions is obtained for weak external sources, and a unified description of both the static and time-varying solutions is given. Also, we demonstrate that the previously found bifurcation in the presence of strong sources is characterized by a zero-eigenvalue mode which dominates the behavior of the solutions near the bifurcation point. The stability properties of the bifurcating solutions are assessed.

10822 Color-singlet condensation in quantum chromodynamics and flux squeezing. Fukuda, R. (Fermi National Accelerator Labora-

tory, P.O. Box 500, Batavia, Illinois 60510). *Phys. Rev., D;* **21**: No. 2, 485-503(15 Jan 1980).

The nonperturbative condensation of the operator G/sub munu/ ² in quantum chromodynamics is discussed using the renormalization-group technique. It is shown that magnetic condensation, < G/sub munu/ ² >>0, leads to a new vacuum which has lower energy than the perturbative vacuum. From this fact it is concluded that Green's functions calculated in the normal vacuum have tachyonic singularities. By assuming the gauge-invariant local expansion of the effective action it is shown that the condensed vacuum has the property of a vanishing dielectric constant. If the color electric field is applied by introducing heavy quarks at infinity, the condensation is partly broken and there is a consistent solution in which an infinite tube of the color electric flux is formed. Arguments used rely heavily on the instability of the normal vacuum and on the negative character of the β function. An attempt at the mean-field-type approximation is made. Comparison with the previous phenomenological approach is also given.

10823 Scalar-field algebraic chromodynamics. Adler, S.L. (The Institute for Advanced Study, Princeton, New Jersey 08540). EY-76-S-02-2220. *Phys. Rev., D;* **21**: No. 2, 550(15 Jan 1980).

I give the Lagrangian density and field equations for a generalized scalar-field chromodynamics, which has full local gauge invariance under general operator-valued gauge transformations.

10824 Partons and their transverse momenta in quantum chromodynamics. Soper, D.E. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). EY-76-S-06-2230. *Phys. Rev. Lett.;* **43**: No. 25, 1847-1851(17 Dec 1979).

It is argued that the parton distribution function P/sub a// A(x,k/sub T/;zeta) is well defined and useful in quantum chromodynamics. Here zeta= (2P/sub A/xn)²/(-n²) arises as a variable because of the use of the axial gauge nxA=0. An approximation for P/sub a//A(x,k/sub T/;zeta) is given which is obtained from an approximate solution of the Bethe-Salpeter equation in the axial-gauge ladder model.

10825 Operator-product expansion in dimensional renormalization. Gupta, S. (Department of Physics, Columbia University, New York, New York 10027). *Phys. Rev., D;* **20**: No. 12, 3160-3167(15 Dec 1979).

In this paper a dimensional renormalization scheme is first modified by making use of the Bogolubov-Parasiuk-Hepp-Zimmermann technique of dealing with overlapping divergences. This scheme is then used to derive the Zimmermann identity to show that this is a valid prescription. A generalized method of obtaining higher operators in the operator-product expansion of the operator T:A (x+ξ) A (x-ξ): is discussed.

10826 Instantons as a bridge between weak and strong coupling in quantum chromodynamics. Callan, C.G. Jr.; Dashen, R.F.; Gross, D.J. (Princeton University, Princeton, New Jersey 08540). EY-76-S-02-2220. *Phys. Rev., D;* **20**: No. 12, 3279-3291(15 Dec 1979).

The transition from weak to strong coupling in quantum chromodynamics is discussed using semiclassical methods to calculate the effective coupling g (a) of an effective lattice theory as a function of a. We demonstrate that the renormalization effects due to instantons cause a sharp transition from weak to strong coupling in the range g (a) $\simeq$ 1.5—3. This is verified by showing that the "string tension" as well as the β function calculated by semiclassical methods match their strong-coupling behavior for g $\simeq$ 1.5—3. An independent test of this notion is provided by a bag-model calculation of the string tension.

10827 Conditions for renormalizability of quantum flavor dynamics. Frampton, P.H. (Department of Physics, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., D;* **20**: No. 12, 3372-3377(15 Dec 1979).

The presence of a new anomaly, in addition to the Adler-Bell-Jackiw (ABJ) anomaly, is hinted at for gauge theories with γ_5 couplings. The ABJ anomaly is discussed first by translation of variables of a linearly divergent integral, then by dimensional regularization. Using the second method, the general non-Abelian case is considered in the presence of an overlapping divergence. A new anomaly is suggested which is not, in general, canceled by the usual restrictions because fermion masses are involved. Assuming no cancellation between different Feynman diagrams and current-algebra quark masses then leads to the conclusion that the standard model of quantum flavor dynamics (i.e., that of Glashow, Salam, and Weinberg) might be nonrenormalizable. Imposition of renormalizability would then imply that new dynamical constraints be met. Hence, only that part of the quark mass corresponding to the lepton mass in the same quark-lepton generation is generated by the electroweak interactions. The remaining mass comes presumably from the strong interaction for which the dynamical theory must therefore have at least some flavor dependence.

10828 Axial-vector current and dimensional regularization. Gottlieb, S.; Donohue, J.T. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **20**: No. 12, 3378-3389(15 Dec 1979).

The properties of the axial-vector current are investigated using the dimensional-regularization scheme. The problem of defining an appropriate generalization of γ_5 in n dimensions is discussed, and previous work is briefly reviewed. For the VVA triangle, in QED, we find that the dimensional scheme provides for vector current conservation, with the divergence of the axial-vector current anomalous. This is shown unambiguously without specifying the anticommuting nature of γ_5 in n dimensions. If one arranges to have two species of fermions with different masses and equal but opposite couplings to the axial-vector current, the VVA anomaly is proportional to n-4, being fully canceled only at n=4. However, the behavior of the triangle amplitude for large external momenta is reduced by two powers, and the resulting softened triangle does not give rise to any finite (as n $\rightarrow$ 4) anomalies when inserted in higher-order diagrams. Finally, the appropriate generalization of γ_5 for even-parity fermion loops is shown to be totally anticommuting, and the validity of Ward identities for two-point functions is demonstrated.

10829 Effects of heavy particles through factorization and renormalization group. Kazama, Y.; Yao, Y. (Randall Laboratory of Physics, University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev. Lett.;* **43**: No. 21, 1562-1566(19 Nov 1979).

For renormalizable theories without spontaneous symmetry breaking, a formalism is developed to systematically extract and evaluate the effects of heavy particles in low-energy physics through factorized local operators and the renormalization group. As an application, quantum electrodynamics with electrons and muons is considered and the effects of muons on the electron anomalous magnetic moment are assessed.

10830 Exact classical solutions to the two-dimensional sigma model: an unusual application of inverse scattering techniques. Campbell, D.K. (Los Alamos Scientific Lab., NM). *Rocky Mt. J. Math.;* **8**: No. 1-2, 371-392(Win 1978).

The development of semi-classical approximation methods in quantum field theories has stimulated substantial interest in localized solutions to the non-linear, partial differential equations corresponding to the classical limits of the quantized equations of motion. Some exact solitary wave solutions to the classical field equations of the sigma model studied in elementary particle and nuclear physics are constructed in one space--one time dimension. The method of constructing these solutions provides a somewhat unusual application of inverse scattering techniques, in that the eigenfunctions of the associated linear problem appear as driving terms in the nonlinear evolution equation. The approach and results lead directly to several interesting mathematical questions, the answers to which would be very useful for further studies in this area.

SCATTERING THEORY

10831 (ORO—3992-369) Discrete states buried in the continuum. Sudarshan, E.C.G. (Texas Univ., Austin (USA). Center for Particle Theory). Aug 1979. Contract EY-76-S-05-3992. 11p. Dep. NTIS, PC A02/MF A01.

It is possible to have discrete normalizable eigenstates of energy with eigenvalues overlapping the continuous spectrum. A simple collection of examples exhibiting this behaviour is presented.

10832 Dominant partition method. Dixon, R.M.; Redish, E.F. (Department of Physics, Morgan State University, Baltimore, Maryland 21239). *J. Math. Phys. (N.Y.);* **21**: No. 2, 372-377(Feb 1980).

Employing the L'Huillier, Redish, and Tandy (LRT) wave function formalism we develop a partially connected method for obtaining few-body reductions of the many-body problem in the LRT and Bencze, Redish, and Sloan (BRS) formalisms. This method for systematically constructing fewer body models for the N-body LRT and BRS equations is termed the dominant partition method (DPM). The DPM maps the many-body problem to a fewer-body one using the criterion that the truncated formalism must be such that consistency with the full Schroedinger equation is preserved. The DPM is based on a class of new forms for the irreducible cluster potential, introduced in the LRT formalism. Connectivity is maintained with respect to all partitions containing a given partition which is referred to as the dominant partition. Degrees of freedom corresponding to the breakup of one or more of the clusters of the dominant partition are treated in a disconnected manner. This approach for simplifying the complicated BRS equations is appropriate for physical problems where a few-body reaction mechanism prevails. We also show that the dominant-partition-truncated form of the BRS equations may be obtained by distributing the residual interaction in the exit channel in a manner consistent with the dominant partition truncations of the irreducible cluster potential.

PHYSICS RESEARCH (CONT.)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 10834

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10783, 10784

10833 Elastic and inelastic scattering of pions from ^{7}Li at T/sub π/ = 164 MeV. Bolger, J. (Kernforschungszentrum, Karlsruhe, Germany); Boschitz, E.; Mischke, R.; Nagel, A.; Saathoff, W.; Wiedner, C.; Zichy, J. pp 519-520 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The elastic and inelastic scattering of positive and negative pions from ^{7}Li was investigated at 164 MeV. Angular distributions were measured between 27 and 93°. The ratios of the π^{-}/π^{+} cross sections were determined for several states. 6 references. (JFP)

10834 Neutron mass: Measurement of the ^{1}H(n,γ)^{2}H γ ray and revised values for selected neutron binding energies. Greenwood, R.C.; Chrien, R.E. (Idaho National Engineering Laboratory, E.G. and G. Idaho, Inc., Idaho Falls, Idaho 83401). *Phys. Rev., C;* **21**: No. 2, 498-502(Feb 1980).

The ^{1}H(n,γ)^{2}H reaction γ-ray energy was obtained from measurement of the energy difference between it and the 2185-keV γ ray emitted in the β^{-} decay of ^{144}Ce-^{144}Pr. Based on the γ-ray energy value of 2223.247 +- 0.017 keV obtained from this measurement, a value of 2224.564 +- 0.017 keV was determined for the binding energy of the deuteron S/sub n/(^{2}H). By combining this binding energy value with published mass differences of doublets involving neighboring isotopes and ^{1}H and ^{2}H, values of 6257.268 +- 0.024, 4946.329 +- 0.024, 8176.483 +- 0.040, and 10833.297 +- 0.038 keV were obtained for the neutron binding energies of ^{3}H, ^{13}C, ^{14}C, and ^{15}N, respectively, together with a value of 8071.367 +- 0.029 keV for the neutron mass excess n-1.

10835 Tensor analyzing powers in ^{4}He(d,d)^{4}He elastic scattering between 17 and 45 MeV. Stephenson, E.J.; Conzett, H.E.; Larimer, R.M.; Leemann, B.T.; Roy, R.; von Rossen, P. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev., C;* **21**: No. 1, 44-53(Jan 1980).

Angular distribution measurements were made of the differential cross section dσ/dΩ and the tensor analyzing powers A/sub y/y and A/sub x/x in d-α elastic scattering between deuteron beam energies of 17 and 45 MeV. The analyzing powers are large over this energy range and suitable for use as a secondary polarization standard. The use of rapid spin flip on the polarized ion source appreciably reduced experimental errors.

10836 Hopes and realities for the (p,π) reaction. Measday, D.F.; Miller, G.A. (Physics Department, University of British Columbia, Vancouver, British Columbia, Canada V6T 1W5). *Annu. Rev. Nucl. Sci.;* **29**: No. 1, 121-160(Dec 1979).

Theory and experimental results are reviewed for the (p,π) reactions including polarization effects and cross section fluctuations. (AIP)

10837 Pion induced deuteron breakup at 350 MeV/c. Hoftiezer, J.H. (Rice Univ., Houston, TX); Mutchler, G.S.; von Witsch, W. pp 252-253 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The pion induced deuteron breakup reaction d(π^{+-},pπ^{+-})n was studied in a kinematically complete counter experiment at 350 MeV/c. Preliminary results for a typical spectrum are shown plotted versus the proton momentum and versus the spectator neutron momentum. Also shown is a theoretical prediction for the differential cross section. In the region of small momentum transfer where the quasifree scattering mechanism dominates, the ratio of π^{+} to π^{-} data agrees with isospin predictions. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10838, 10839

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10916

10838 Inelastic pion scattering from ^{18}O. Lee, T.H.; Lawson, R.D. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **21**: No. 2, 679-690(Feb 1980).

The inelastic scattering of 164 MeV pions from ^{18}O is studied using the distorted-wave impulse approximation in momentum space. The sensitivity of the predictions to various shell model descriptions of the yrast 2^{+} state is examined in detail. The excitation of the triplet of states (4^{+}_{1}, 0^{+}_{2}, 2^{+}_{2}) near 3.7 MeV and the (3^{-}_{1}, 0^{+}_{3}, 2^{+}_{3}) triplet at about 5.2 MeV are also investigated within the context of the shell model. In order to explain the scattering to natural parity states [those with angular momentum J and parity (-1)/sup J/], one must enhance the theoretical results by about the same factor as needed to explain the B (EJ; 0 → J) transition rates obtained from electromagnetic excitation. The sensitivity of the results to the isoscalar or isovector character of this enhancement is examined. Agreement between distorted-wave impulse approximation calculations and experiment is found to be satisfactory.

10839 Fusion doorway states in the ^{12}C+^{12}C system. Lemmer, R.H.; Toepffer, C. (Department of Physics and Nuclear Physics Research Unit, University of the Witwatersrand, Johannesburg, South Africa). W-7405-ENG-26. *Phys. Rev. Lett.;* **44**: No. 1, 26-29(7 Jan 1980).

The role of isoscalar giant quadrupole excitations in ^{24}Mg as doorway states for symmetric fission and intermediate structure resonances in ^{12}C+^{12}C elastic scattering is investigated by means of model calculations using particle-hole excitations over two major shells. The fission mode is treated as a shape degree of freedom that couples the giant quadrupole resonances in ^{24}Mg to the ground state. The associated intermediate-structure resonances have calculated widths for symmetric fission and γ decay that are in qualitative agreement with experiment.

10840 Pion-nucleus inelastic scattering and the nuclear shell model. Lee, T.S.H.; Kurath, D.; Lawson, R. (Argonne National Lab., IL). pp 603 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The momentum space distorted wave impulse approximation was used to carry out calculations of pion inelastic scattering from the 1p-shell nuclei ^{18}O and ^{28}Si using the shell model. In the study of 1p-shell nuclei the validity of distorted wave impulse approximation is critically examined and sensitivities of pion inelastic scattering to the shell models are investigated. 3 references. (JFP)

10841 Scattering of a pion by the nuclear pion cloud. Truex, W.S. (Univ. of Maryland, College Park); Banerjee, M.K.; Cammarata, J.B. pp 263-264 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The question is considered of whether the nuclear pion cloud interaction effect is significant in any situation. It is found that in the case of pion-nucleus scattering lengths for oxygen 16 the exchange current effect is about 10% of the total, which is regarded as a significant effect. The diagram where the external pion scatters off a pion in flight between two nucleons is considered. This result makes a very srong case for developing a careful theory of scattering lengths. 4 references. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

MASS, ABUNDANCE, AND BINDING ENERGY

REFER ALSO TO CITATION(S) 10834

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10843, 10844, 10845, 10847, 10848, 10852, 10853, 10854

10842 Spin-flip and isospin-flip transitions in ^{12}C by positive-pion scattering. Boudrie, R.L. (Univ. of Colorado, Boulder); DiGiacomo, N.J.; Kraushaar, J.J. pp 530-531 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A recent inelastic positive-pion scattering experiment has provided well resolved good statistics spectra showing clearly the excitation of the 1^+ (as well as other) states. Angular distributions were obtained at 140 to 260 MeV. (JFP)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10836, 10842

10843 Photoneutron cross sections for ^{17}O. Jury, J.W.; Berman, B.L.; Faul, D.D.; Meyer, P.; Woodworth, J.G. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). W-7405-ENG-48. *Phys. Rev., C;* **21**: No. 2, 503-511(Feb 1980).

Photoneutron cross sections involving the emission of one and two neutrons from ^{17}O have been measured over the energy interval 8.5 to 39.7 MeV using monoenergetic photons from positron in-flight annihilation. The 6-MeV wide giant dipole resonance is observed to be centered at 23 MeV and a pygmy resonance is seen at about 13 MeV. Such structure as is apparent in the cross sections is not as pronounced as for the cases of ^{16}O and ^{18}O. Comparison of the total photoneutron cross section with recent ground-state data indicates that much of the pygmy resonance decays to the ground or first excited state of ^{16}O, but that the giant dipole resonance decays mainly to highly excited states in the daughter. Excellent agreement is observed between the present results and a recent two-particle, one-hole shell-model calculation of the isospin-split giant dipole resonance states for this nucleus. New photoneutron cross-section results for ^{16}O up to 39.7 MeV are reported as well.

10844 ^{7}Li and ^{13}C(p,d) reactions at T/sub p/=800 MeV. Bauer, T.S.; Adams, G.S.; Igo, G.J.; Pauletta, G.; Whitten, C.A.; Smith, G.R.; Shepard, J.R.; Anderson, R.E.; Boudrie, R.L.; DiGiacomo, N.J.; Kraushaar, J.J.; Peterson, R.J.; Hoffmann, G. (University of California, Los Angeles, California 90024). *Phys. Rev., C;* **21**: No. 2, 757-760(Feb 1980).

Cross sections for the ^{7}Li(p,d)^{6}Li and ^{13}C(p,d)^{13}C reactions have been measured at a bombarding energy of 800 MeV. Exact finite range distorted-wave Born-approximation calculations are compared to cross sections for known levels excited by 1p neutron pickup and are found to give reasonable agreement in most cases. However, the large strength for the excitation of the 2.184 MeV ^{6}Li 3^+ level is not reproduced by the calculation. Levels in ^{12}C are strongly excited at 800 MeV which are not appreciably populated in lower energy (p,d) studies.

10845 m-substate populations in resonant heavy-ion reactions. Beene, J.R.; DeVries, R.M.; Shapira, D.; Clover, M.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 1, 167-174(Jan 1980).

We have employed the line shape analysis technique to study nuclear spin alignment produced in the $^{12}C+^{16}O$ reaction populating the 2^+ 4.43-MeV state in ^{12}C. We present excitation functions of m-substate population P (m) measured in the range E/sub c.m./ =19—22.6 MeV and detailed angular distributions of P (m) obtained at E/sub c.m./=21.7, 21.9, and 22.3 MeV. Results have been analyzed in terms of a single resonance with sharp spin in the compound nucleus and found to contradict previous spin assignment based on studies of angular distributions of cross section in the E/sub c.m./ ≃ 22 to 22.6-MeV region.

10846 Energy dependence of $^{40}Ca+^{12}C$ elastic scattering at 90° and 180°. Kubono, S.; Bond, P.D.; Horn, D.; Renner, T.R. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **21**: No. 1, 459-461(Jan 1980).

Excitation functions have been measured for the elastic scattering of $^{40}Ca+^{12}C$ at 180° and 90°. The excitation functions at the two angles are found to be anticorrelated, an effect which is quite similar to that observed previously in $^{28}Si+^{16}O$ and $^{28}Si+^{12}C$ elastic scattering. It is found from distorted-wave Born-approximation analyses of the energy dependence that the one-step elastic transfer process is probably not responsible for the observed resonancelike structure around 180° nor for the anticorrelation in the excitation functions at the two angles in $^{40}Ca+^{12}C$ scattering.

10847 Measurement of the ratio σ ($^{12}C(\pi^+,\pi^+p)^{11}B$)/$\sigma$ ($^{12}C(\pi^-,\pi^-p)^{11}B$). Ziock, H.J.; Ellis, R.J.; Ziock, K.O.H.; Bolger, J.; Boschitz, E.; Arvieux, J.; Corfu, R.; Piffaretti, J. (Physics Department, University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev. Lett.;* **43**: No. 26, 1919-1921(24 Dec 1979).

The cross section of the pion-induced proton-knockout reaction $^{12}C \rightarrow {}^{11}B$ has been measured with positive and negative pions. The ratio of the cross sections is compared with the ratio calculated in the plane-wave impulse approximation and agreement is found for those events that lead to particle-stable final states.

10848 Electron scattering, isospin mixing, and the structure of the 12.71- and 15.11-MeV levels in ^{12}C. Flanz, J.B.; Hicks, R.S.; Lindgren, R.A.; Peterson, G.A.; Dubach, J.; Haxton, W.C. (Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003). *Phys. Rev. Lett.;* **43**: No. 26, 1922-1925(24 Dec 1979).

The structure and the degree of isospin mixing for the 1^+ levels in ^{12}C at 12.71 MeV (T=0) and 15.11 MeV (T=1) are determined from measured 180°-electron-scattering form factors. The resulting charge-dependent isospin-mixing matrix element ranges from 130 to 165 keV depending on the theoretical model of the isoscalar form factor.

10849 Production of neutron-rich nuclides by fragmentation of 212-MeV/amu ^{48}Ca. Westfall, G.D.; Symons, T.J.M.; Greiner, D.E.; Heckman, H.H.; Lindstrom, P.J.; Mahoney, J.; Shotter, A.C.; Scott, D.K.; Crawford, H.J.; McParland, C.; Awes, T.C.; Gelbke, C.K.; Kidd, J.M. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94620). *Phys. Rev. Lett.;* **43**: No. 25, 1859-1862(17 Dec 1979).

Yields of neutron-rich projectile fragments have been measured at 0° for the reaction of 212-MeV/amu ^{48}Ca ions on an 890-mg-cm^{-2} beryllium target. Fourteen nuclides have been observed for the first time. The systematics of production cross sections are discussed.

10850 Orbiting in the $^{12}C+^{20}Ne$ system. Shapira, D.; Ford, J.L.C. Jr.; Gomez del Campo, J.; Stokstad, R.G.; DeVries, R.M. (Oak Ridge National Laboratory, Oak ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev. Lett.;* **43**: No. 24, 1781-1784(10 Dec 1979).

An experimental study of the $^{20}Ne+^{12}C$ systems reveals a large cross section for inelastic scattering with large negative Q-values at backward angles. The differential cross section is proportional to l/sin θ/sub c.m./ for θ/sub c.m./>100° and has characteristics consistent with the decay of an orbiting $^{20}Ne+^{12}C$ dinuclear system.

10851 Energy dependence of charged pions produced at 180° in 0.8—4.89-GeV proton-nucleus collisions. Schroeder, L.S.; Chessin, S.A.; Geaga, J.V.; Grossiord, J.Y.; Harris, J.W.; Hendrie, D.L.; Treuhaft, R.; Van Bibber, K. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 24, 1787-1791(10 Dec 1979).

High-energy charged pions produced at 180° in 0.8—4.89-GeV proton-nucleus collisions have been studied. Both the slopes of the energy spectra and the π^-/π^+ ratios increase rapidly with primary energy up to ~ 3—4 GeV, where limiting values appear to be reached. The dependence on target mass also changes over this energy range. Unlike forward pion production results, backward pions at these energies do not obey the scaling law suggested by Schmidt and Blankenbecker.

10852 Angular distributions for the reaction $^{18}O(\pi^+,\pi^-)^{18}Ne$ and pion double—charge-exchange form factors. Seth, K.K.; Iverson, S.; Nann, H.; Kaletka, M.; Hird, J.; Thiessen, H.A. (Northwestern University, Evanston, Illinois 60201). *Phys. Rev. Lett.;* **43**: No. 21, 1574-1577(19 Nov 1979).

The first angular distributions for pion double charge exchange to discrete nuclear states are reported. The analog and nonanalog states are found to be equally strongly populated. The direct, surface dominated nature of the reaction is clearly demonstrated by the angular distribution shapes. It is shown that in order to produce detailed agreement with the data, the preseat ideas for the pion charge-exchange form factors may need to be drastically revised.

10853 π-^{13}C scattering near the πN (3,3) resonance. Schwarz, E.; Egger, J.; Goetz, F.; Gretillat, P.; Lunke, C.; Perrin, C.; Preedom, B.M.; Mischke, R.E. (Institut de Physique, Universite de Neuchatel, CH-2000 Neuchatel, Switzerland). *Phys. Rev. Lett.;* **43**: No. 21, 1578-1580(19 Nov 1979).

π-^{13}C elastic and inelastic scattering was measured for both π^+ and π^- at 180 MeV. The π^-/π^+ ratio of inelastic cross sections approaches 1 in scattering to collective states, whereas this ratio differs significantly from 1 for other excited states. In particular, a value close to the one for pion scattering from free nucleons at the (3,3) resonance was determined for the 9.5 MeV state.

10854 Total cross section for (γ,π^-) reactions in the Δ region. Bosted, P.E.; Blomqvist, K.I.; Bernstein, A.M. (Physics Department and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). EY-76-C-02-3069. *Phys. Rev. Lett.;* **43**: No. 20, 1473-1476(12 Nov 1979).

Total—
been measured from threshold to 360 MeV photon energy by detecting the radioactivity of the residual nuclei, thereby singling out the ground state of ^{12}N and the ground and first exited states of ^{7}Be. The cross sections are found to peak at about 40 MeV pion energy and then to fall gradually. In contrast to pion charge exchange and other photopion experiments, these results are well reproduced both in shape and in magnitude by distorted-wave impulse-approximation calculations.

10855 Thick-target measurements and astrophysical thermonuclear reactions rates: Proton-induced reactions. Roughton, N.A.; Fritts, M.R.; Peterson, R.J.; Zaidins, C.S.; Hansen, C.J. (Regis College and Nuclear Physics Laboratory University of Colorado, Boulder, Colorado 80309). *At. Data Nucl. Data Tables;* **23**: No. 2, 177-194(Feb 1979).

We have studied 72 proton-induced reactions on a variety of targets from ^{10}B through ^{152}Sm. These include (rho,α), (rho,γ), and (rho,n) reactions leading to various β or β and γ unstable final state nuclei. By measurement of the activity of the product nucleus we extract a normalized thick-target yield as a function of the energy in the center-of-mass system. An appropriate integration in energy of the yield function then allows calculation of the thermonuclear reaction rate, N/sub A/$<\sigma v>$/sub T/, as a function of temperature. Extensive tables of yields and rates are given primarily for use in astrophysical applications.

10856 Enhancement of ^{12}C inelastic scattering near the (3,3) resonance. Cottingame, W.B. (Univ. of Texas, Austin); Moore, I.B.; Braithwaite, W.J. pp 524 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Pion inelastic scattering on ^{12}C exhibits strong enhancement for excitation energies in the region of 19.3 to 21.6 MeV, for incident pion energies near the pion-nucleon (3,3) resonance. From the total and differential cross section measurements it is concluded that the (3,3) resonance may provide a mechanism for selective enhancement of pion inelastic scattering to these states. Angular distributions for such states were measured for an incident pion energy of 180 MeV to assist in making the proper assignments from the proposed candidates. Also measurements were taken at incident pion energies of 100 through 291 MeV to determine the excitation function for states in this region. (JFP)

10857 K^--^{12}C elastic scattering at 800 MeV/c. Marlow, D. (Carnegie-Mellon Univ., Pittsburgh, PA); Barnes, P.; Dytman, S. pp 714 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The differential cross sections were measured for elastic K^- scattering from carbon-12 at 800 MeV/c. The energy spectra obtained show good separation for all states below 10 MeV. The preliminary elastic angular distribution is shown. These calculations are a reasonable representation of the data. 3 references. (JFP)

10858 (π^+,p) reaction on ^{12}C and ^{13}C near 90 and 180 MeV. Anderson, R.E. (Los Alamos Scientific Lab., NM); Hoffman, E.W.; Hoeistad, B.; Macek, R.J.; Morris, C.L.; Thiessen, H.A.; Boudrie, R.L.; Smith, G.R.; Kaellne, J. pp 194 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Sufficient resolution was obtained for the studied reactions what unambiguous separation of several discrete levels in the residual nuclei, and numerous angular distributions were obtained between angles of 10 and 115°. Angular distributions for the ^{11} ^{12}C transitions are shown. (JFP)

10859 (π,p) reaction in ^{6} ^{7}Li at 75 and 175 MeV. Kaellne, J. (Univ. of Virginia, Charlottesville); Davis, J.; Gugelot, P.C.; McCarthy, J.S.; Smith, G.; Boudrie, R.; Hoeistad, B.; Morris, C.L. pp 195-196 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The (π^+,p) reaction in ^{6} ^{7}Li was measured with regard to angular distribution at 75 and 175 MeV energy. For lithium 6 both (π^+,p) and (π^-,p) were studied. The importance of pion rescattering is noted. 1 reference. (JFP)

10860 ^{11}C production yield ratios from ^{12}C vs ^{13}C and ^{12}C vs ^{16}O for incident π^{+-} from 100 to 250 MeV. Aniol, K. (Univ. of Washington, Seattle); Chiang, D.; Halpern, I.; Drake, D.; Haouat, G. pp 276 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Carbon 11 production ratios from ^{12}C, ^{13}C, and ^{16}O using π^{+-} beams are plotted and discussed. (JFP)

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10840

10861 (LA-tr—79-43) Momentum-dependent state densities in the exciton model. Medler, P.; Raif, R. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). 1979. Translation of ZFK—376, pp 11-14. (CONF-7711135—1(Trans)). 9p. Dep. NTIS, PC A02/MF A01.

From Symposium on the interaction of fast neutrons with nuclei; Gaussig, German Democratic Republic (21 Nov 1977).

In the simplest closed form of the exciton model the density of states is introduced as a function of its total momentum, in addition to being a function of the energy of the n-exciton gas. The angular distributions for the reactions ^{27}Al (p, p') when E/sub p/ = 62 MeV and ^{93}Nb (n, n') when E/sub n/ = 14 Mev are considered. The applicability of this approach is briefly discussed. 5 references.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10864

10862 First 8^+ state in ^{28}Si and level systematics of sd shell nuclei. Ford, J.L.C. Jr.; Cleary, T.P.; Gomez del Campo, J.; Hensley, D.C.; Shapira, D.; Toth, K.S. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 2, 764-767(Feb 1980).

Differential cross sections for the ^{25}Mg(^{12}C,^{9}Be) reaction were measured at θ/sub L/=10, 15, 20° for bombarding energies near 100 and 120 MeV. These data are consistent with direct ^{3}He transfer to highly excited, high-spin states in ^{28}Si. The energy spectra, angular distributions, level systematics of sd-shell nuclei, and shell-model calculations strongly suggest that a state observed at 15.8 MeV is the previously unidentified 8^+ member of the ground-state rotational band of ^{28}Si.

10863 Excitation of high spin particle-hole states in ^{28}Si by pion inelastic scattering. Geesaman, D.F. (Argonne National Lab., IL); Olmer, C.; Zeidman, B.; Segel, R.E.; Swenson, L.W.; Boudrie, R.L.; Morris, C.L.; Thiessen, H.A. pp 532 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The excitation of high spin particle-hole states in silicon 28 was studied by the inelastic scattering of 162-MeV π^+ at large momentum transfer. The data demonstrate that pion inelastic scattering is an excellent tool for studying both T = 0 and 1 spin-flip excitations in nuclei. (JFP)

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10783, 10784, 10851, 10862, 10863

10864 Resonance structure of ^{32}S+n from measurements of neutron total and capture cross sections. Halperin, J.; Johnson, C.H.; Winters, R.R.; Macklin, R.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 2, 545-562(Feb 1980).

Neutron total and capture cross sections of ^{32}S have been measured up to 1100 keV neutron energy [E/sub exc/(^{33}S) =9700 keV]. Spin and parity assignments have been made for 28 of the 64 resonances found in this region. Values of total radiation widths, reduced neutron widths, level spacings, and neutron strength functions have been evaluated for s/sub 1/2/, p/sub 1/2/, p/sub 3/2/, and d/sub 5/2/ levels. Single particle contributions using the valency model account for a significant portion of the total radiation width only for the p/sub 1/2/-wave resonances. A significant number of resonances can be identified with reported levels excited in ^{32}S(d,p) and ^{29}Si(α,n) reactions. A calculation of the Maxwellian average cross section appropriate to stellar interiors indicates an average capture cross section at 30 keV, sigma-bar $\simeq$ 4.2(2) mb, a result that is relatively insensitive to the assumed stellar temperature.

Direct (potential) capture and the s-wave resonance capture contributions to the thermal capture cross section do not fully account for the reported thermal cross section (530 +- 40 mb) and a bound state is invoked to account for the discrepancy.

10865 Search for fusion oscillations in the $^{16}O+^{28}Si$ system. Betts, R.R.; Hindi, M.M.; DiCenzo, S.B.; Parker, P.D. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06520). EY-76-C-02-3074. *Phys. Rev., C;* **21**: No. 1, 175-178(Jan 1980).

The yields of gamma rays from evaporation residues following the fusion of $^{16}O+^{28}Si$ have been measured over the energy range 50 —65 MeV in a search for structure similar to that found in the backward angle elastic scattering of this system. No such structure is seen at a level of about 4% of the total fusion cross section.

10866 Elastic and inelastic scattering of 162 MeV pions by ^{28}Si, ^{58}Ni, and ^{208}Pb. Olmer, C.; Geesaman, D.F.; Zeidman, B.; Chakravarti, S.; Lee, T.H.; Boudrie, R.L.; Siemssen, R.H.; Amann, J.F.; Morris, C.L.; Thiessen, H.A.; Burleson, G.R.; Devereux, M.J.; Segel, R.E.; Swenson, L.W. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **21**: No. 1, 254-271(Jan 1980).

Angular distributions for the elastic and inelastic scattering of 162 MeV π^+ and π^- by Si, ^{58}Ni, and ^{208}Pb have been measured. The elastic scattering data are fitted with optical model calculations in configuration space. Momentum-space optical-model calculations qualitatively reproduce the elastic scattering data, but substantially better agreement can be obtained if suitable modifications to the model are made. Distorted-wave impulse approximation calculations of the inelastic scattering, using both configuration-space and momentum-space models, generally reproduce the experimental data.

10867 Observation of spin flip in $^{13}C+^{24}Mg$ inelastic scattering. Duennweber, W.; Bond, P.D.; Chasman, C.; Kubono, S. (Brookhaven National Laboratory, Upton, New York 11973). EY-76-C-02-0016. *Phys. Rev. Lett.;* **43**: No. 22, 1642-1645(26 Nov 1979).

Evidence for spin dependent interactions in heavy ion reactions has been found in the inelastic scattering of 35-MeV ^{13}C from the 1.368-MeV, 2^+ state in ^{24}Mg. Gamma rays emitted perpendicular to the reaction plane have been measured and vertical barmvertical-bar substate populations deduced. At ^{13}C scattering angles θ/sub cm/=10° and 21°, probabilities for the vertical-barmvertical-bar=1 population (which is equivalent to spin-flip) are found to be 1.7 +- 0.5% and less than 0.8%, respectively.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

10868 Identification and decay of neutron-rich ^{39}S. Hill, J.C.; Petry, R.F.; Wang, K.H. (Ames Laboratory: USDOE and Department of Physics, Iowa State University, Ames, Iowa 50011). *Phys. Rev., C;* **21**: No. 1, 384-390(Jan 1980).

The previously unreported decay of ^{39}S has been studied from sources prepared in the $^{40}Ar(n,2p)^{39}S$ reaction using intermediate energy neutrons. The ^{39}S half-life was measured to be 11.5 +- 0.5 sec. On the basis of results from γ singles and coincidence measurements, all six γ rays observed in ^{39}S decay were placed in a level scheme for ^{39}Cl consisting of excited states at 397, 1301, 1697, 1785, and 2571 keV. Our levels are compared with results from reaction studies and shell-model calculations and a discussion of the possible nature of the negative-parity states is given.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10771, 10855, 10866, 10869, 10869

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

10869 (CONF-7909105—1) **Fast neutron total and scattering cross sections of chromium, iron and ^{60}Ni.** Smith, A.B.; Guenther, P.T.; Whalen, J.F. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 30p. Dep. NTIS, PC A03/MF A01.

From NEANDC topical discussion Central Bureau of Nuclear Measurement; Geel, Belgium (18 Sep 1979).

Neutron total cross sections are measured with broad resolutions (50 to 100 keV) from $\approx$ 1.0 to 4.5 MeV at intervals of $\leqq$ 50 keV and to accuracies of $\approx$ 1%. Differential elastic scattering cross sections are measured at $\geqq$ 10 scattering angles distributed between 20 and 160° from $\approx$ 1.5 to 4.0 MeV at intervals of $\leqq$ 50 keV. Angle-integrated elastic scattering cross sections are deduced from the measured values to accuracies of $\geqq$ 5%. Inelastically scattered neutrons are observed up to incident neutron energies of 4.0 MeV at scattering angles distributed between 20 and 160°. Cross sections are determined corresponding to the excitation of observed states at: Chromium - 1433, 2377, 2665, 2778, and 2970 keV; Iron - 853, 1389, 2097, 2579, 2677, 2974, and 3152 keV; and ^{60}Ni - 1342, 2168, 2304, 2509, 2636, and 3164 keV. The experimental results are discussed in terms of conventional optical-statistical models and in the context of direct-scattering processes. The experimental and calculational results are compared with the corresponding evaluated quantities given in the ENDF/B file. 21 references.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 10868, 10873, 10874

10870 (CONF-790968—7) **Masses of new isotopes in the fp shell.** Davids, C.N. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 14p. Dep. NTIS, PC A02/MF A01.

From 6. international conference on atomic masses; East Lansing, MI, USA (18 Sep 1979).

A total of four new neutron-rich isotopes were studied including ^{53}Ti, ^{57}Cr, ^{59}Mn, and ^{60}Mn. The bombardment of ^{58}Ni by various heavy ion beams resulted in the discovery of proton-rich ^{67}As and permitted extensive measurements of the superallowed decays of ^{65}Ge, ^{66}As, and ^{70}Br. 13 references. (JFP)

10871 K-shell ionization in the electron and positron decays of ^{64}Cu. Schupp, G.; Freedman, M.S. (Physics Department, University of Missouri-Columbia, Columbia, Missouri 65211). *Phys. Rev., C;* **21**: No. 1, 348-360(Jan 1980).

The total K-ionization probabilities accompanying the β^+ and β^- decays of ^{64}Cu, P/sub K/(β^+), and P/sub K/(β^-) were determined from coincidence and singles K x-ray spectra of Ni and Zn to be (13.2 +- 0.8) x 10^{-4} and (11.9 +- 0.8) x 10^{-4}, respectively, using a high resolution Si(Li) photon spectrometer. P/sub K/(β^+)/P/sub K/(β^-) was measured directly and independently to be 1.26 +- 0.10, in fair agreement with the ratio of the separate measurements 1.11 +- 0.10. While the average ratio is in agreement with the shaking theory of Isozumi, Shimizu, and Mukoyama, the individual values are a factor of $\sim$ 1.5 larger than their predictions. A similar approximately twofold excess over the Isozumi, Shimizu, and Mukoyama hydrogenic-wave-function-based predictions has been observed for almost all cases of K-shell shaking in β^- decay, and now also for this first reported measurement in β^+ decay. The measured ratio is the first experimental evidence affirming the previously recognized and acknowledged error of a factor of 2 (excess) for shakeoff in β^- decay (but not in β^+ decay) in the theory of Law and Campbell. No evidence was found for a postulated Ni K vacancy production mechanism, in which the positron annihilates with a K electron internal to the parent atom, exceeding a few percent of K shaking in positron decay.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10869, 10870

10872 High-spin levels and band structure in ^{78}Kr. Robinson, R.L.; Kim, H.J.; Sayer, R.O.; Milner, W.T.; Piercey, R.B.; Hamilton, J.H.; Ramayya, A.V.; Wells, J.C. Jr.; Caffrey, A.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., C;* **21**: No. 2, 603-613(Feb 1980).

The high-spin states of ^{78}Kr have been studied through observation of γ rays emitted from the $^{68}Zn(^{12}C,2n)$ reaction produced with projectile energies of 33—38 MeV. The energies, relative intensities, angular distributions, and linear polarizations of the γ rays were measured. Lifetimes of states were obtained from the Doppler broadening of the γ-ray peaks. Many of the levels appear to belong to one of three bands: (1) the ground-state band with energy spacing between that given by the pure rotational and vibrational models, (2) a band built on a 5^- state which is ascribed to rotational alignment of two quasiparticles, one of which is in a g/sub 9/2/ orbital, and (3) a $\Delta J=1$ band which has characteristics of a γ-vibrational band in a deformed nucleus. There is evidence for the beginning of a fourth band built on a J=6 level.

10873 Nuclear data sheets for A=60. Auble, R.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). W-7405-ENG-26. *Nucl. Data Sheets;* **28**: No. 2, 103-178(Oct 1979).

Nuclear structure data available through April 1979 are compiled and evaluated. Adopted level and decay properties are given. The bulk of the data is presented pictorially for easy comparison. Experimental details, references, and additional comments, where

required, are given in the text. All drawings, tables, and comments are reproduced from the Evaluated Nuclear Structure Data File (ENSDF). Any additions or corrections desired by the users should be addressed to the evaluators for maintenance and updating of the data file.

10874 Nuclear data sheets for A=64. Halbert, M.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). W-7405-ENG-26. *Nucl. Data Sheets;* **28**: No. 2, 179-266(Oct 1979).

Nuclear structure data available through March 15, 1979, are evaluated, and adopted level and gamma properties are given. The bulk of the data is presented pictorially for easy comparison. Experimental details, references, comments, and additional data are given in the text. All drawings, tables, and comments are reproduced from the computerized Evaluated Nuclear Structure Data File (ENSDF). Any additions or corrections desired by the users should be addressed to the evaluators for maintenance and updating of the computer file.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10851, 10855, 10868, 10872

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

10875 ^{147}Tb and proton single particle states near Z=64. Chasman, R.R. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). W-31-109-ENG-38. *Phys. Rev., C;* **21**: No. 1, 456-458(Jan 1980).

Proton single particle level spacings near Z=64 are deduced from an analysis of low-lying levels in ^{145}Eu, using a pairing force as the residual interaction. Two forms for the pairing force are explored. Using this spectrum, high spin states in ^{144}Sm, ^{146}Gd, and ^{148}Dy are calculated and compared with known experimental values when possible. The low-lying states in ^{143}Pm and ^{147}Tb are also calculated. The need for experimental data on ^{147}Tb is emphasized.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10861

10876 Time-dependent Hartree-Fock fusion calculations in ^{86}Kr+^{139}La and ^{84}Kr+^{209}Bi collisions. Davies, K.T.R.; Devi, K.R.S.; Strayer, M.R. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). EY-76-C-02-3074;W-7405-ENG-26. *Phys. Rev. Lett.;* **44**: No. 1, 23-26(7 Jan 1980).

Time-dependent Hartree-Fock fusion calculations are presented for head-on collisions of ^{86}Kr+^{139}La and ^{84}Kr+^{209}Bi. A large fusion region is found for moderately high energies above the Coulomb barrier, and a lower limit for the fusion cross section of ^{84}Kr+^{209}Bi → $^{293}_{119}$X* is estimated from non—head-on collisions. Also fusionlike behavior is found for a narrow range of energies near the barrier.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 10880, 10881, 10882

10877 Beta decay of ^{99}Tc/sup m/. Alburger, D.E.; Richards, P.; Ku, T.H. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **21**: No. 2, 705-711(Feb 1980).

The emission of β rays from 6.02-h ^{99}Tc/sup m/ has been detected with an intermediate-image magnetic spectrometer. β-ray components with end-point energies of 434.8 +- 2.6 keV (β_0) to the ^{99}Ru ground state and 346.7 +- 2.0 keV (β_1) to the 90-keV state were found with intensities per decay of (1.0 +- 0.3) x 10^{-5} for β_0 and (2.6 +- 0.5) x 10^{-5} for β_1. In the Kurie plot analysis the unique first-forbidden "α" shape was assumed for β_0 and an allowed shape was assumed for β_1. Values of log f_1t=9.39 +- 0.11 for β_0 and log f_0t=8.66 +- 0.08 for β_1 were derived. γ rays of 322, 233, and 140 keV were observed in a calibrated Ge(Li) detector with relative source intensities of I_{322}:I_{233}:I_{140}= (1.13 +- 0.09) x 10^{-6}:(0.95 +- 0.17) x 10^{-7}:1.000. The total β-ray branching of 3.7 x 10^{-5} results in a negligible correction to dosage calculations in the use of ^{99}Tc/sup m/ for diagnostic nuclear medicine.

10878 Decays of mass-separated ^{139}Xe and ^{139}Cs. Lee, M.A.; Talbert, W.L. Jr. (Ames Laboratory : United States Department of Energy and Department of Physics, Iowa State University, Ames, Iowa 50010). *Phys. Rev., C;* **21**: No. 1, 328-343(Jan 1980).

The β and subsequent γ decays of ^{139}Xe and ^{139}Cs have been studied using an on-line isotope separator system. Ge(Li) γ-ray singles and Ge(Li) -Ge(Li) γ-γ coincidence measurements were used to construct level schemes for ^{139}Cs and ^{139}Ba. For the decay of ^{139}Xe, 213 of 230 observed γ-ray transitions have been placed in a level scheme for ^{139}Cs with 55 excited states. For the decay of ^{139}Cs, 167 of 179 observed γ-ray transitions are placed in a level scheme for ^{139}Ba with 59 excited states. The Q values for the β decays of ^{139}Xe and ^{139}Cs were determined from Ge(Li) plastic scintillator coincidence measurements as 5.02 +- 0.06 and 4.29 +- 0.07 MeV, respectively. Ground-state β branches were deduced for the ^{139}Xe and ^{139}Cs decays using relative γ-ray intensities. Spin and parity assignments for levels in ^{139}Cs and ^{139}Ba have been deduced using β-decay logft values, γ-ray transition rates, and reaction data in the literature. Interpretation of some of the energy levels is made from a shell-model viewpoint.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10481, 10877, 10878, 10884

10879 ^{109}Pd: Difficulties in particle-rotor models for unique-parity states and revision of spectroscopic factors. Casten, R.F.; Smith, G.J.; Macphail, M.R.; Breitig, D.; Kane, W.R.; Stelts, M.L.; Mughabghab, S.F.; Cizewski, J.A.; Boerner, H.G.; Davidson, W.F.; Schreckenbach, K. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **21**: No. 1, 65-97(Jan 1980).

Primary and secondary γ rays following thermal and p-wave resonant (2.96 eV) neutron capture on ^{108}Pd were measured to study γ-ray transitions in ^{109}Pd. Average resonance capture spectra at 2 and 24 keV were also recorded and the ^{108}Pd(n,γce) reaction was studied and transition multipolarities were deduced. A detailed level scheme up to ~ 1400 keV has been constructed. Numerous spin assignments have been revised, leading to substantial changes in the (d,p) and (d,t) spectroscopic factors, in particular for the g/sub 7/2/ orbit. The data on primary transition intensities for the 2.96 eV resonance are compared with the valence neutron capture model. The level scheme deduced for ^{109}Pd sheds new light on the previously proposed g/sub 7/2/-h/sub 11/2/ anomaly in the filling of these orbits, suggesting that, at least in ^{109}Pd, the appearance of the anomaly was largely due to spin misassignments. The revised systematics in the occupation of shell model orbits for a number of nuclei in this mass region is reviewed. Within the level scheme is a group of low-spin negative-parity levels which belong to the same family as the high-spin, decoupled, unique-parity states known in other odd mass Pd isotopes. These states correspond to the favored and unfavored anti-aligned levels for core rotations R < or = 6. Calculations in the framework of the particle-rotor model cannot reproduce these level energies.

10880 Nuclear data sheets for A=101. Harmatz, B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). W-7405-ENG-26. *Nucl. Data Sheets;* **28**: No. 3, 343-402(Nov 1979).

Nuclear structure information available to May 1979 has been reviewed. The level properties obtained from decay and reaction experiments are shown in the drawings. Experimental methods, references, and comments are given in the text.

10881 Nuclear data sheets for A=103. Harmatz, B. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). W-7405-ENG-26. *Nucl. Data Sheets;* **28**: No. 3, 403-483(Nov 1979).

Nuclear structure information pertaining to A=103 has been reviewed. The level properties obtained from decay and reaction experiments are shown in the drawings. Experimental methods, references, and comments are given in the text.

10882 Nuclear data sheets for A=140. Peker, L.K. (National Nuclear Data Center Brookhaven National Laboratory Upton, New York 11973, USA). EY-76-C-02-0016. *Nucl. Data Sheets;* **28**: No. 2, 267-342(Oct 1979).

The experimental nuclear structure data available through August 1978 have been reviewed. A summary of information obtained in various reaction and decay experiments is presented, together with adopted level schemes.

10883 Giant multipole resonances and inelastic pion scattering. Bertrand, F.E. (Oak Ridge National Lab., TN). pp 230-251 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A short review is provided of what was learned about the nondipole giant resonances during the last few years. The advantages that might be gained through use of inelastic pion scattering are described; and finally it is shown what the current experimental situation is with regard to pion excitation of these resonances. The

various spectra and angular distributions are shown and discussed. 17 references. (JFP)

MOMENTS AND SPIN

10884 (DOE/TIC—11017) **Survey of ground state magnetic dipole strength.** Horen, D.J. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 18p. Dep. NTIS, PC A02/MF A01.

The experimental status of ground-state magnetic dipole radiative strength is surveyed. Radiative transitions are tabulated for a large number of nuclei for which significant strength was observed. Fragmentary evidence tends to imply that the centroid of the GMDR might be independent of the nuclear mass number for A > 40, and lie at ~ 10 MeV. There still exists very little information on M1 strength in A > 40 nuclei. Status of the data in the lead region is reviewed. 42 references.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10851, 10855, 10879, 10883, 10891, 10892

10885 (CONF-790847—14) **Pion reaction modes on nuclei.** Schiffer, J.P. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 33p. Dep. NTIS, PC A03/MF A01.

From International conference on high energy physics and nuclear structure; Vancouver, Canada (13 Aug 1979).

Portions of this document are illegible.

The status of the overall features of recent inclusive data on pion-induced reactions on nuclei is summarized. Simple features of absorption and inelastic scattering are discussed.

10886 (CONF-791223—2) **Neodymium, samarium and europium capture cross-section adjustments based on EBR-II integral measurements.** Anderl, R.A.; Harker, Y.D.; Schmittroth, F. (Idaho National Engineering Lab., Idaho Falls (USA); Hanford Engineering Development Lab., Richland, WA (USA)). 1979. Contract EY-76-C-07-1570. 12p. Dep. NTIS, PC A02/MF A01.

From NEANDC specialist meeting on neutron cross sections of fission product nuclei; Bologna, Italy (12 Dec 1979).

Integral capture measurements were made for highly enriched isotopes of neodymium, samarium, and europium irradiated in a row 8 position of EBR-II with samples located both at mid-plane and in the axial reflector. Broad response, resonance, and threshold dosimeters were included to characterize the neutron spectra at the sample locations. The saturation reaction rates for the rare-earth samples were determined by post-irradiation mass-spectrometric analyses and for the dosimeter materials by the gamma-spectrometric method. The HEDL maximum-likelihood analysis code, FERRET, was used to make a least-squares adjustment of the ENDF/B-IV rare-earth cross sections based on the measured dosimeter and fission-product reaction rates. Preliminary results to date indicate a need for a significant upward adjustment of the capture cross sections for ^{143}Nd, ^{145}Nd, ^{147}Sm, and ^{148}Sm. 8 figures, 2 tables.

10887 Fusion and emission of ^{1}H and ^{4}He in reactions between complex nuclei at high energies. Delagrange, H.; Logan, D.; Rivet, M.F.; Rajagopalan, M.; Alexander, J.M.; Zisman, M.S.; Kaplan, M.; Ball, J.W. (Department of Chemistry, State University of New York at Stony Brook, Stony Brook, New York 11794). *Phys. Rev. Lett.;* **43**: No. 20, 1490-1493(12 Nov 1979).

We have measured cross sections for evaporation residues, fission, and direct and evaporative ^{1}H and ^{4}He in reactions of 222—340-MeV ^{40}Ar with ^{116}Sn, ^{154}Sm, ^{164}Dy, and ^{197}Au. Fusion cross sections are also presented for 77—167-MeV ^{12}C + ^{182}W and 187-MeV ^{40}Ar + ^{116}Sn. The Z dependence of the evaporative H/He indicates a breakdown of phase-space models for fission-evaporation competition. The large cross sections observed for direct H/He emission force serious consideration of energy dissipation by H/He ejection during the initial impact.

10888 Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979). 798p. (CONF-790347—).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The conference contained 165 papers. Separate abstracts were prepared for each paper. (JFP)

10889 Properties of pion single charge exchange reactions in nuclei. Bowles, T. (Argonne National Lab., IL); Geesaman, D.F.; Holt, R.J. pp 271 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Pion single charge exchange reactions initiated by π^+ and π^- beams were surveyed on targets ranging from Be to Pb at 50 to 200 MeV. The more complete angular distributions determine the total charge exchange cross section, whose dependence on pion charge and target mass can be investigated. The importance of other reactions mechanisms is inferred. 1 reference. (JFP)

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 10891

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10883

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10883

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10887

10890 /sup 186,187,188/Os(n,γ) cross sections and galactic nucleosynthesis. Winters, R.R.; Macklin, R.L.; Halperin, J. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **21**: No. 2, 563-573(Feb 1980).

The /sup 186,187,188/Os(n,γ) cross sections were measured over the incident neutron energy range 2.6—800 keV. Optimized statistical model fits to the average cross sections were made employing estimates of the ^{186}Os, ^{187}Os, and ^{188}Os p-wave strength functions 0.29 x 10^{-4}, 0.45 x 10^{-4}, and 0.33 x 10^{-4}, respectively, d-wave strength functions 1.3 x 10^{-4}, 4.0 x 10^{-4}, and 1.5 x 10^{-4}, respectively, and gamma ray strength functions (Gamma-bar/sub γ//D_0) 26.8 x 10^{-4}, 176 x 10^{-4}, and 20.8 x 10^{-4}, respectively. A lower bound for the ^{187}Os neutron inelastic cross section is estimated as 0.25(20) b at 30 keV. The Maxwellian-averaged capture cross sections are presented as a function of temperature. The ratio of 30 keV Maxwellian-averaged cross sections $<\sigma/$sub $\gamma/(186)>/<\sigma/$sub $\gamma/(187)>=0.504(17)$ is reported and the lack of agreement with earlier measurements of this ratio is discussed. The use of this cross section ratio in estimating, via the ^{187}Re-^{187}Os beta decay, the duration of galactic nucleosynthesis is discussed. The cross section ratio from this work yields an estimate of 10.4(25) x 10^{9} yr for the duration of galactic nucleosynthesis, a result higher than but still consistent with the estimate 7(2) x 10^{9} yr derived from U/Th decay.

10891 Study of the role of complete fusion in the reaction of calcium-48 and iron-56 with cerium and terbium. Morrissey, D.J. Berkeley, CA; Univ. of California (1978). 85p. University Microfilms Order No. 79-04,556.

Thesis (Ph. D.).

^{48}Ca and ^{56}Fe beams from the SuperHILAC accelerator were used to irradiate thick metal foils of cerium and terbium. Product gamma-ray activities were detected off line, and individual products were identified by half-life gamma-ray energy, and gamma-ray abundances. The production cross sections were iteratively fit to charge and mass dispersions to allow correction for parent decay and calculation of mass yields. From the mass yield curves contributions from quasielastic transfer, deep inelastic transfer, and complete fusion reaction mechanisms were inferred. Complete fusion was made up of contributions from both evaporation residue and fusion-fission products for the ^{48}Ca-induced reactions. However, only fusion-fission products were detected in the ^{56}Fe-induced reactions. Critical angular momenta for fusion were found to be 82 +- 8 h-bar for ^{48}Ca + ^{159}Tb and 34 +- 5 h-bar for ^{56}Fe + ^{140}Ce, which can be compared with previous values of 53 +- 8 h-bar for ^{12}C + ^{197}Au and 86 +- 5 h-bar for ^{40}Ar + ^{165}Ho. All of these reactions lead to essentially the same compound nucleus, and seem to show the dramatic decline in complete fusion for heavy ions larger than ^{40}Ar. The prediction of this decline was found to be beyond the model calculations of Bass and the critical distance approach of Glas and Mosel.

10892 Dependence of deep-inelastic processes on entrance channel asymmetry and excitation energy. Schmitt, R.P. Berkeley, CA; Univ. of California (1978). 188p. University Microfilms Order No. 79-04,596.

Thesis (Ph. D.).

The dependence of deep-inelastic processes on entrance channel asymmetry and excitation energy was investigated. Thin targets of /sup nat/Ag, ^{159}Tb, ^{181}Ta, and ^{197}Au were bombarded with 620-MeV ^{86}Kr ions. Additional measurements were performed on the

reactions /sup nat/Ag + ^{86}Kr and ^{197}Au + ^{86}Kr at 506 and 732 MeV incident energy. The energy spectra, the charge distributions and the angular distributions of these fragments were measured. At 620 MeV the energy spectra show that the distinction between quasi-elastic and deep-inelastic processes diminishes as the target mass is increased. The charge distributions tend to become increasingly asymmetric for the heavier systems. The angular distributions exhibit a strong dependence on the entrance channel asymmetry. The results at 506 and 732 MeV show that the widths of the charge distributions is strongly dependent on the excitation energy. Even though the charge distributions are much narrower at lower bombarding energies, the character of the charge distributions are retained throughout the range of bombarding energies. The angular distributions for the reaction /sup nat/Ag + ^{86}Kr become increasingly more forward peaked at higher bombarding energies. The angular distributions for ^{197}Au + ^{86}Kr, which are strongly focused at 506 MeV, also tend to be more forward peaked at the highest incident energy. The results are interpreted by assuming that the projectile and target form an intermediate complex and that they exchange mass via a diffusion process.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 10891

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

10893 Macroscopic description of isoscalar giant multipole resonances. Nix, J.R.; Sierk, A.J. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **21**: No. 1, 396-404(Jan 1980).

On the basis of a simple macroscopic model, we calculate the isoscalar giant-resonance energy as a function of mass number and multipole degree. The restoring force is determined from the distortion of the Fermi surface, and the inertia is determined for the incompressible, irrotational flow of nucleons with unit effective mass. With no adjustable parameters, the resulting closed expression reproduces correctly the available experimental data, namely the magnitude and dependence upon mass number of the giant quadrupole energy and the magnitude of the giant octupole energy for ^{208}Pb. We also calculate the isoscalar giant-resonance width as a function of mass number and multipole degree for various macroscopic damping mechanisms, including two-body viscosity, one-body dissipation, and modified one-body dissipation. None of these damping mechanisms reproduces correctly all features of the available experimental data, namely the magnitude and dependence upon mass number of the giant quadrupole width and the magnitude of the giant octupole width for ^{208}Pb.

MOMENTS AND SPIN

REFER ALSO TO CITATION(S) 10893

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10876

10894 Effects of collectivity on target-fragmentation reactions. Cumming, J.B. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **44**: No. 1, 17-20(7 Jan 1980).

A new approach based on the collective tube model is developed for understanding momentum transfer to target fragments in high-energy hadron-nucleus collisions. Collectivity manifests itself in an enhanced dependence of momentum transfer on projectile energy, consistent with experimental results for deep-spallation reactions. The effective target for ^{149}Tb production from ^{197}Au by high-energy protons is deduced to consist of 3.1 +- 0.4 nucleons. Extensions of this model to nucleus-nucleus collisions are discussed.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 10897

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 10898

10895 Characterization of level schemes for ^{195}Tl and ^{197}Tl from radioactive decay of the lead parents. Collins, L.L. Jr. Knoxville, TN; Univ. of Tennessee (1978). 213p. University Microfilms Order No. 79-03,410.

Thesis (Ph. D.).

The level schemes for ^{195}Tl and ^{197}Tl were characterized by studying the radioactive decay of ^{195}Pb and ^{197}Pb. Multiscaled gamma-ray singles data and gamma-gamma coincidence data were collected with Ge(Li) semiconductor radiation detectors, and internal-conversion electron spectra were collected with a Si(Li) semiconductor radiation detector. In ^{195}Tl and ^{197}Tl the s/sub 1/2/, d/sub 3/2/, d/sub 5/2/, and h/sub 11/2/, shell-model states were observed and interpreted as hole states coupled to even-even Pb cores. In ^{195}Tl the h/sub 9/2/ structure observed includes yrast levels with I/sup π/ = 9/2$^-$ to 13/2$^-$ and ten other levels up to 1930 keV, and in ^{197}Tl the h/sub 9/2/ structure includes yrast levels of I/sup π/ = 9/2$^-$ to 17/2$^-$ with 19 other levels up to 2821 keV. This work reports characterization of the h/sub 11/2/ proton hole state and an impressive structure of levels that decay only to the 11/2$^-$ state at 1361.8 keV and 1382.8 keV, respectively, in ^{195}Tl and ^{197}Tl. In ^{195}Tl are reported five low-spin levels in addition to the 3/2$^+$, first excited state. These levels are evidence for some ground-state decay in ^{195}Pb. In ^{197}Tl, in addition to the first excited, 3/2$^+$ state, 19 other levels up to 2430 keV are reported. These levels are populated by ^{197}Pb ground-state decay, which is populatedby an isomeric transition in ^{197}Pb. These additional low-spin, positive-parity levels in ^{197}Tl can be understood in terms of coupling of the s/sub 1/2/, d/sub 3/2/, and d/sub 5/2/ single-particle states with the 2+ and 4+ states of the ^{198}Pb core.

10896 Nuclear structure of ^{193}Os. Warner, D.D.; Davidson, W.F.; Boerner, H.G. (Institut Max von Laue - Paul Langevin, 38 - Grenoble (France)); Casten, R.F. (Brookhaven National Lab., Upton, NY (USA)); Namenson, A.I. (Naval Research Lab., Washington, DC (USA)). *Nucl. Phys., A;* **316**: No. 1-2, 13-31(1979).

The energy levels of ^{193}Os have been investigated using the ^{192}Os(n, γ)^{193}Os reaction. Precise energy measurements of secondary γ-rays have been made with the high resolution curved crystal spectrometers and high flux of thermal neutrons available at the ILL. Primary γ-rays following average resonance capture with a mean neutron energy of 2 keV were studied at Brookhaven National Laboratory. The two sets of results have been combined with existing data to construct a level scheme up to 1300 keV incorporating a complete set of 1/2$^-$, 3/2$^-$ states. Unique or limited spin assignments have been made for most of the levels. It has been shown that, as a result of the significant reduction in the fragmentation of single particle strength, the essential features of the states below 700 keV can be understood in terms of Coriolis coupled Nilsson model states.

10897 Nuclear data sheets for A=196. Halperin, J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA). W-7405-ENG-26. *Nucl. Data Sheets;* **28**: No. 3, 485-558(Nov 1979).

Nuclear structure data for mass chain A=196 available up to September 1, 1978, are included in this compilation. Level and gamma properties obtained from various reaction and decay experiments are presented in tabulations and drawings of level schemes. Inconsistencies and discrepancies are noted, and adopted values for level and gamma-ray properties are given.

MOMENTS AND SPIN

10898 Fragment spin orientation in deep-inelastic reactions from anisotropy measurements of continuum γ rays. Aguer, P.; Schmitt, R.P.; Wozniak, G.J.; Habs, D.; Diamond, R.M.; Ellegaard, C.; Hillis, D.L.; Hsu, C.C.; Mathews, G.J.; Moretto, L.G.; Rattazzi, G.U.; Roulet, C.P.; Stephens, F.S. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 24, 1778-1781(10 Dec 1979).

The in-plane and out-of-plane anisotropy has been measured for γ rays in coincidence with deep-inelastic products from the 1064-MeV ^{136}Xe+ ^{197}Au reaction. The γ-ray energy spectra exhibit a bump corresponding to a dominantly stretched-E2 cascade, but only a small out-of-plane anisotropy, indicating a misalignment of the fragment spins. A simple model is used to extract a rms misalignment angle of 34° +- 7°.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10851, 10866, 10887, 10892, 10895, 10896, 10898

10899 (CONF-791058—64) **Measured and evaluated bismuth data for fusion-fission-hybrid and electro-nuclear breeding applications.** Guenther, P.T.; Smith, A.B.; Smith, D.L.; Whalen, J.F.; Howerton, R. (Argonne National Lab., IL (USA); California Univ.,

Livermore (USA). Lawrence Livermore Lab.). 1979. Contract W-31-109-ENG-38. 7p. Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

Neutron total and scattering cross sections of elemental bismuth are measured to energies of approximately 4.5 MeV. The experimental results are used to deduce an optical-statistical model that is quantitatively descriptive of the measured values and of higher-energy results reported in the literature. The measured and calculated values, together with the body of information available in the literature, are utilized to derive a comprehensive evaluated nuclear data file in the ENDF format. This evaluation extends from 10^{-5} eV to 20 MeV, addresses neutron-induced and photon-emission processes, and is oriented toward the needs of fusion-fission-hybrid and electro-nuclear breeding applications. 4 figures, 1 table.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

10900 (LA—8073-MS) **Gamma measurements on spherical shells of ^{239}Pu and ^{238}U.** Bendt, P.J.; Jurney, E.T. (Los Alamos Scientific Lab., NM (USA)). Oct 1979. Contract W-7405-ENG-36. 12p. Dep. NTIS, PC A02/MF A01.

The gamma spectra from two ^{239}Pu spherical shells and an identical ^{238}U shell 67-mm o.d. and 2.2 mm thick were measured with NaI(Tl) and Ge(Li) detectors. The plutonium shells differed in the ^{240}Pu content. The intrinsic gamma radiation at 2 m from the shells was 93.3 μrem/h (5.93% ^{240}Pu); 67.3 μrem/h (2.65% ^{240}Pu); and 0.69 μrem/h (tuballoy with 0.2% ^{235}U). The NaI(Tl) spectrum is given in photons/cm^2-s and in mrem/h for 10 keV energy bins to 1 MeV for the plutonium shells, and for 25 keV energy bins to 3 MeV for the tuballoy shell. The decay chains leading to the prominent gamma lines in the Ge(Li) spectra are discussed. 2 references.

10901 **Isoscalar giant resonances in ^{232}Th.** Harakeh, M.N.; Morsch, H.P.; van der Weg, K.; van der Woude, A.; Bertrand, F.E. (Kernfysisch Versneller Instituut, Groningen, The Netherlands). *Phys. Rev., C;* **21**: No. 2, 768-771(Feb 1980).

The giant resonance region in ^{232}Th has been studied with inelastic α scattering at E/sub α/=120 MeV. The observed resonance peak can be fitted with one Gaussian peak centered at 11.0 +- 0.3 MeV with full width at half maximum equal to 4.0 +- 0.3 MeV. If pure L=2, this peak would exhaust (130 +- 25) % of the E2 energy-weighted sum rule. Considerable admixture of L=0 and/or higher multipole strength could be accommodated, if only 60 —80% of the E2 energy-weighted sum rule is assumed to be exhausted.

10902 **Optical isomer shift for the spontaneous-fission isomer ^{240}Am/sup m/.** Bemis, C.E. Jr.; Beene, J.R.; Young, J.P.; Kramer, S.D. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-ENG-26-7405. *Phys. Rev. Lett.;* **43**: No. 25, 1854-1858(17 Dec 1979).

The optical isomer shift in the ^{8}S/sub 7/2/ → ^{10}P/sub 7/2/ atomic transition in neutral americium has been measured for the ~ 1-ms spontaneously fissioning isomer, ^{240}Am/sup m/(SF). With use of a laser-excited optical pumping technique, this transition is shifted by +2.6 +- 0.2 A to 6407.2 +- 0.2 A implying a difference in nuclear mean square radii, $\delta\langle r^2\rangle$, of 5.1 +- 0.2 fm^2 between the fission isomer and the normal ground state. These experiments provide the first direct experimental proof for the large deformations expected for fission isomers.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10901, 10902

10903 (CONF-791058—65) **Measurement of the fast neutron capture cross section of ^{238}U relative to ^{235}U(n,f).** Fawcett, L.R. Jr.; Poenitz, W.P.; Smith, D.L. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 7p. 02.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The capture cross section of ^{238}U was measured using the activation technique and ^{235}U(n,f) as a reference cross section. Capture events were measured by detection of two prominent γ-transitions in the decay of the ^{239}U daughter nuclide, ^{239}Np, employing a high resolution Ge(Li) detector. The system was calibrated with samples activated in a thermal neutron flux relative to the capture cross section of gold, and with an absolutely calibrated α-emitter, ^{243}Am, which decays to ^{239}Np. Cross section measurements were carried out in the neutron energy range from 30 keV to 3 MeV. Emphasis was on absolute values between 150 keV and 1 MeV where the ^{238}U(n,γ) cross section and its cross section is small. Background from fission products was found to restrict the accuracy of the measured data at energies > 1.5 MeV.

10904 **Measurement of the inclusive neutron production by relativistic neon ions on uranium.** Schimmerling, W.; Kast, J.W.; Ortendahl, D.; Madey, R.; Cecil, R.A.; Anderson, B.D.; Baldwin, A.R. (Lawrence Berkeley Laboratory, Berkeley, California 94720). *Phys. Rev. Lett.;* **43**: No. 27, 1985-1987(31 Dec 1979).

Inclusive double-differential cross sections for neutron production were measured at 337 MeV/nucleon in the reaction Ne+U → n+X. Neutrons were detected with energies between ~ 12 and ~ 600 MeV at laboratory angles of 30°, 45°, 60°, and 90°. The neutron spectra above ~ 30 MeV are comparable with the predictions of a "firestreak" calculation. The neutron spectra differ from proton spectra reported for U and Pb.

SPONTANEOUS AND INDUCED FISSION

REFER ALSO TO CITATION(S) 10878, 10902

10905 (CONF-791058—48) **Fission cross section of ^{230}Th and ^{232}Th relative to ^{235}U.** Meadows, J.W. (Argonne National Lab., IL (USA)). 1979. Contract W-31-109-ENG-38. 4p. Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The fission cross sections of ^{230}Th and ^{232}Th were measured relative to ^{235}U from near threshold to near 10 MeV. The weights of the thorium samples were determined by isotopic dilution. The weight of the uranium deposit was based on specific activity measurements of a ^{234}U-^{235}U mixture and low geometry alpha counting. Corrections were made for thermal background, loss of fragments in the deposits, neutron scattering in the detector assembly, sample geometry, sample composition and the spectrum of the neutron source. Generally the systematic errors were ~ 1%. The combined systematic and statistical errors were typically 1.5%. 17 references.

10906 **Neutron multiplicity measurements of Cf and Fm isotopes.** Hoffman, D.C.; Ford, G.P.; Balagna, J.P.; Veeser, L.R. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **21**: No. 2, 637-646(Feb 1980).

Prompt neutrons in coincidence with the fission fragments from the spontaneous fission of /sup 250,252,254/Cf and ^{257}Fm were measured inside a 75-cm-diameter, Gd-loaded liquid scintillation counter having a neutron-detection efficiency of about 78%. Measurements for ^{256}Fm were done just outside the counter with an efficiency of 31%. The kinetic energies of both fission fragments and the number of neutrons for each fission event were recorded. From these data, the fragment kinetic energies and masses and the neutron multiplicity distributions were determined for /sup 250,252,254/Cf and ^{257}Fm. Variances of neutron multiplicity distributions as a function of total fragment kinetic energy and the ratio of fragment masses have been calculated and are presented for all the nuclides studied.

10907 **Fission barriers for ^{255}Es, ^{256}Es, and ^{255}Fm.** Britt, H.C.; Cheifetz, E.; Hoffman, D.C.; Wilhelmy, J.B.; Dupzyk, R.J.; Lougheed, R.W. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **21**: No. 2, 761-763(Feb 1980).

Fission coincidence data are presented for (d,pf), (t,pf), and (^{3}He,df) reactions on a ^{254}Es target. A possible resonance is observed in ^{255}Es. Estimates for the height of the first peak of the fission barrier for ^{255}Es, ^{256}Es, and ^{255}Fm are presented. The possibility of additional structure in the potential energy surface in the vicinity of the first peak of the fission barrier is discussed.

NUCLEAR THEORY

REFER ALSO TO CITATION(S) 10888

NUCLEAR STRUCTURE

REFER ALSO TO CITATION(S) 10914, 10917

10908 (BNL—27077) **Application of catastrophe theory to nuclear structure.** Scharff-Goldhaber, G.; Dresden, M. (Brookhaven National Lab., Upton, NY (USA); State Univ. of New York, Stony Brook (USA). Inst. for Theoretical Physics). 1979. Contract EY-76-C-02-0016. 25p. Dep. NTIS, PC A02/MF A01.

Three two-parameter models, one describing an A-body system (the atomic nucleus) and two describing many-body systems (the van der Waals gas and the ferroelectric (perovskite) system) are compared within the framework of catastrophe theory. It is shown that each has a critical point (second-order phase transition) when the two counteracting forces controlling it are in balance; further,

each undergoes a first-order phase transition when one of the forces vanishes (the deforming force for the nucleus, the attractive force for the van der Waals gas, and the dielectric constant for the perovskite). Finally, when both parameters are kept constant, a kind of phase transition may occur at a critical angular momentum, critical pressure, and critical electric field. 3 figures, 1 table.

10909 Multipole operators in semileptonic weak and electromagnetic interactions with nuclei Harmonic Oscillator Single-Particle Matrix Elements. Donnelly, T.W.; Haxton, W.C. (Institute of Theoretical Physics, Department of Physics Standard University, Stanford, California 94305). *At. Data Nucl. Data Tables;* **23**: No. 2, 103-176(Feb 1979).

We discuss the multipole operators that arise in treatments of semileptonic weak and electromagnetic interactions with nuclei. Tables in which exact expressions for the single-particle matrix elements of these operators in a harmonic oscillator basis are given for a wide range of oscillator shells. Together with some approximation to the one-body density matrix, these tables will allow the reader to calculate with ease cross sections for (e,e'), real photon processes, β-decay, and charged lepton capture, as well as those for many more exotic semileptonic interactions (charged and neutral current neutrino reactions, (μ,e) conversion, etc.). A specific example, elastic magnetic electron scattering from ^{27}Al, is considered in detail.

10910 Pions and isobars in nuclei: an overview. Moniz, E.J. (Massachusetts Inst. of Tech., Cambridge). pp 288-305 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A brief review is given in which an attempt is made to assess present understanding of the pion and Δ-hold propagators in nuclei beginning in the resonance region and working down to the question of deltas in nuclear ground state wave functions. Pion-nucleus scattering in the resonance region, pionic atoms, and meson exchange currents and deltas in the nuclear ground state ω/sub π/ ≈ 0 are considered. 5 references. (JFP)

NUCLEAR MATTER

10911 Evidence for a soft nuclear-matter equation of state. Siemens, P.J.; Kapusta, J.I. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 20, 1486-1489(12 Nov 1979).

The entropy of the fireball formed in central collisions of heavy nuclei at center-of-mass kinetic energies of a few hundred MeV per nucleon is estimated from the ratio of deuterons to protons at large transverse momentum. The observed paucity of deuterons suggests that strong attractive forces are present in hot, dense nuclear matter, or that degrees of freedom beyond the nucleon and pion may already be realized at an excitation energy of 100 MeV per baryon.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 10909

10912 Comparisons of experimental and theoretical nucleus-nucleus potentials for heavy-ion reactions. Sikora, B.; Blann, M.; Scobel, W.; Bisplinghoff, J.; Beckerman, M. (Institute of Nuclear Physics, Warsaw University, Hoza 69, Warsaw, Poland). *Phys. Rev., C;* **21**: No. 2, 614-619(Feb 1980).

A broad range of heavy-ion-induced fusion excitation functions are classically analyzed. The fusion-barrier parameters are compared with predictions of the proximity potential, a Yukawa-plus-exponential model, and a modified Woods-Saxon potential. The Yukawa-plus-exponential model is found to give the best overall agreement with the data. The proximity potential is too shallow, but would be in closer agreement with data if a necking contribution were added.

10913 Equilibrium statistical treatment of angular momenta associated with collective modes in fission and heavy-ion reactions. Moretto, L.G.; Schmitt, R.P. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev., C;* **21**: No. 1, 204-216(Jan 1980).

The angular momentum effects in deep inelastic processes and fission have been studied in the limit of statistical equilibrium. The model consists of two touching liquid drop spheres. Angular momentum fractionation has been found to occur along the mass asymmetry coordinate. If neutron competition is included (i.e., in compound nucleus formation and fission), the fractionation occurs only to a slight degree, while extensive fractionation is predicted if no neutron competition occurs (i.e., in "fusion-fission" without compound nucleus formation). Thermal fluctuations in the angular momentum are predicted to occur due to degrees of freedom which can bear angular momentum such as wriggling, tilting, bending, and twisting. The coupling of relative motion to one of the wriggling modes, leading to fluctuations between orbital and intrinsic angular momentum, is considered first. Next the effect of the excitation of all the collective modes on the fragment spin is treated. General expressions for the first and second moments of the fragment spins are derived as a function of total angular momentum and the limiting behavior at large and small total angular momentum is examined. Furthermore, the effect of collective mode excitation on the fragment spin alignment is explored and is discussed in light of recent experiments. The relevance of the present study to the measured first and second moments of the γ-ray multiplicities as well as to sequential fission angular distributions is illustrated by applying the results of the theory to a well studied heavy-ion reaction.

10914 Inelastic pion scattering for 1p-shell targets. Lee, T.H.; Kurath, D. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **21**: No. 1, 293-305(Jan 1980).

Inelastic scattering of pions with energy near the (3,3) resonance is calculated with a distorted-wave impulse approximation formulated in momentum space. Results for all 1p-shell targets are given and compared to existing data. Strong transitions are dominated by quadrupole amplitudes, and enhancement factors consistent with observed B (E2) values are needed to attain agreement with observed cross sections in these cases. The sensitivity of pion scattering to isospin effects is noted. This distorted-wave impulse approximation approach appears to offer a reasonable interpretation of inelastic pion scattering.

10915 Correction to the table of differential polarization coefficients for (gamma, particle) reactions. Monahan, J.E.; Holt, R.J.; Laszewski, R.M. (Argonne National Laboratory, Argonne, Illinois 60439). *At. Data Nucl. Data Tables;* **23**: No. 2, 97-98(Feb 1979).

The differential polarization coefficients for photonuclear reactions that are tabulated in Atomic Data and Nuclear Data Tables 19, 305 (1977) are correct if each coefficient is multiplied by the factor (-1)/sup() L+J+S1-L+J+S2/.

10916 Is thera a large local field correction to the π-nucleus optical potential. Wallace, S.J; Banerjee, M.K. (Univ. of Maryland, College Park). pp 596-597 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

The question of whether there is a large local field correction to the pion-nucleus optical potential is considered for the leading triple scattering process using plane waves for the excited states of the nucleon. A complete treatment of spin and isospin is made for pion scattering from ^{16}O. The magnitude of the complex ratio R, which expresses the magnitude of the leading local field correction relative to the magnitude of the first order optical potential is plotted. 2 references. (JFP)

10917 Extensive momentum-space DWIA studies of pion-nucleus inelastic scattering. Lee, T.S.H.; Kurath, D.; Lawson, R.; Chakravarti, S. (Argonne National Lab., IL). pp 600 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

Within the framework of the distorted wave impulse approximation extensive studies of pion-nucleus inelastic scattering were carried out. The obtectives were to examine critically the extent to which the distorted wave impulse approximation method can be valid and to explore nuclear structure from the recent experimental data. (JFP)

10918 How much information of π^--nucleus optical potential can π^--mesonic atom data provide. Seki, R. (California State Univ., Northridge). pp 616-617 of Meson-nuclear physics, 1979 (Houston). Hungerford, E.V. III (ed.). New York, NY; American Institute of Physics (1979).

From 2. international conference on meson-nuclear physics; Houston, TX, USA (5 Mar 1979).

A systematic analysis of the existing shift and width data in π^- mesonic atoms was performed. Both the Kisslinger and Ericson-Ericson forms of the pion-nucleus optical potential are used in order to examine the sensitivity of the data to detailed structure in the low density expansion forms of the potential. The major conclusion is that there exists an intrinsic insensitivity of the data for phenomenological specification of density dependent structure, which results in strong correlations among potential parameters. 8 references. (JFP)

NUCLEAR MODELS

REFER ALSO TO CITATION(S) 10846, 10894, 10908, 10911, 10912, 10913

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 10375

10919 Theoretical and experimental aspects of the energy loss of relativistic heavily ionizing particles. Ahlen, S.P. (Lawrence Berkeley Laboratory and Space Sciences Laboratory, University of California, Berkeley, California 94720). *Rev. Mod. Phys.;* **52**: No. 1, 121-175(Jan 1980).

We review the theory of the electromagnetic interactions between rapidly moving charged particles and the matter through which they pass. The emphasis will be on very massive electric (-100< or =$Z_1$100) and magnetic (vertical-bargvertical-bar=137e and 137e/2) particles moving with relativistic velocities (β>0.2, γ<100). Consideration will be given to both the stopping power of the projectile and to the response of the absorbing medium to the excitation caused by the projectile.

10920 Trapping of positive muons at vacancies in quenched aluminum. Brown, J.A.; Heffner, R.H.; Leon, M.; Schillaci, M.E.; Cooke, D.W.; Gauster, W.B. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **43**: No. 20, 1513-1516(12 Nov 1979).

Evidence is presented for the trapping of positive muons at monovacancies and divacancies in quenched aluminum. The annealing of vacancies as sensed by the muon-spin-rotation effect is compared to positron annihilation measurements on identically prepared samples, showing that whereas positrons are trapped primarily at small vacancy clusters, muons are trapped mainly at monovacancies and divacancies. Furthermore, the data indicate that it may be possible to study monovacancies and divacancies separately with the muon-spin-rotation technique.

10921 (UCRL-Trans—11490) **Influence of temperature on the production and recombination of carriers in alpha-ray columns.** Seitter, W. Translated from *Ann. Phys. (Leipzig);* **34**: No. 2, 113-129(1939). 31p. Dep. NTIS, PC A03/MF A01.

The influence of pressure and temperature on alpha-ray conductivity in air, krypton, and neon was studied by plotting current-pressure curves for various voltages and for a temperature difference of approximately 200°C. The temperature coefficient, $\beta = 1/i\ di/dT$, and relative values of the recombination coefficient, α, were derived as a function of pressure, temperature, and voltage from the observed curves. The temperature coefficient, β, decreases with increasing gas pressure and for krypton and neon approaches zero. The graphically determined saturation currents of the current-voltage curves increase with gas temperature, particularly at the lower densities. This indicates that molecular energy also participates in carrier formation. The attempt to describe the present observations by existing theoretical formulas led to the conclusion that these formulas are inadequate exhaustively to account for the actual processes in the experiments. The recombination coefficient, α, increases slowly with increasing pressure at room temperature for air and approaches a maximum. Within the pressure range studied it decreases with increasing temperature. The influence of temperature on α seems to become less pronounced with increasing density. 13 figures. (RWR)

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 10331, 10501

10922 (BNL—26916) **Use of high resolution γ-ray spectroscopy for neutron cross sections.** Stelts, M.L. (Brookhaven National Lab., Upton, NY (USA)). 1979. Contract EY-76-C-02-0016. 11p. (CONF-791058—63). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear cross sections for technology; Knoxville, TN, USA (22 Oct 1979).

The use of high resolution spectroscopy to resolve some problems in neutron cross section measurements will be discussed. Topics included are: measurements of capture cross sections with the time-of-flight technique in the presence of high backgrounds, measurements of activation cross sections, and determination of neutron fluxes. The use of high resolution spectral data to determine resonance spins will be discussed. Data will be presented on measurement of p-wave neutron strength functions from high resolution γ-spectra from average neutron capture at 2- and 24-keV energy.

10923 (DOE/TIC—110384) **Present needs and future trends in neutron crystallography and spectroscopy.** Williams, J.M. (ed.). (Argonne National Lab., IL (USA)). Nov 1978. Contract W-31-109-ENG-38. 105p. Dep. NTIS, PC A06/MF A01.

Topics covered include: structural investigation by neutron and x-ray diffraction; sources and characteristics of neutron radiation; time-of-flight techniques; overview of neutron crystallography and structural chemistry; hydrogen bonds; transition-metal hydride complexes; actinide and lanthanide complexes; carbon-hydrogen-metal interactions in organometallic chemistry and catalysis; metal clusters and catalysis; materials with unusual solid-state properties; biochemical molecules and biological systems; electron and spin density distributions in crystalline solids; incoherent neutron-scattering spectroscopy; and quasielastic neutron scattering and high resolution spectroscopy. (GHT)

10924 (EUR—6064(Vol.2), pp 699-706) **Wn, computed from recent nuclear data and W measurements.** Coyne, J.J. (National Bureau of Standards, Washington, DC (USA)); Goodman, L.J. (Brookhaven National Lab., Upton, NY (USA)). 1978.

From 6. symposium on microdosimetry; Brussels, Belgium (May 1978).

Initial spectra of secondary charged particles produced by neutrons with energies varying from 60 keV to 20 MeV have been calculated. The most recent nuclear data evaluations have been used: ENDF/B-IV for hydrogen, nitrogen and oxygen and a preliminary version of ENDF/B-V for carbon. Many reactions with more than two particles in the final state are now included. In addition to the $^{12}C(n,n')$ 3α reaction, which was used in previous calculations, the reactions (n,n'p), (n,n'α), (n,2α) and (n,2n) have been calculated. Recent measurements of the average energy per ion pair, W, for protons and other heavy ions have been combined with these initial spectra to derive a value for Wn as a function of neutron energy. Preliminary results of these calculations are presented and comparisons with previous calculations of Wn are presented.

MEDICAL PHYSICS

RADIATION PROTECTION STANDARDS

10925 Medical aspects of radiation protection law contribution to Austrian radiation protection law. Moser, B. pp 157-161 of Vorsorgemedizin und Strahlenschutz (Risiko/Nutzen-Analyse). Erholungsvorgaenge nach Strahleneinwirkung. Medizinische Aspekte der Strahlenschutzgesetzgebung in verschiedenen europaeischen Laendern. Messerschmidt, O.; Moehrle, G.; Zimmer, R.; Holeczke, F.; Kainberger, F.; Kaercher, K.H.; Mader, H.; Seyss, R. (eds.). Stuttgart, Germany, F.R.; Thieme (1977). (In German)

From Joint German-Austrian meeting on radiation protection; Salzburg, Austria (3 Jun 1977).

Some medical aspects of the radiation protection law, esp. in conjunction with medical surveillance of persons exposed to radiation are discussed. The discussion refers to the countries of the European Community and Austria and Switzerland.

DOSIMETRY

10926 (ORNL/TM—6689) **EDISTR: a computer program to obtain a nuclear decay data base for radiation dosimetry.** Dillman, L.T. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 122p. Dep. NTIS, PC A06/MF A01.

This report provides documentation for the computer program EDISTR. EDISTR uses basic radioactive decay data from the Evaluated Nuclear Structure Data File developed and maintained by the Nuclear Data Project at the Oak Ridge National Laboratory as input, and calculates the mean energies and absolute intensities of all principal radiations associated with the radioactive decay of a nuclide. The program is intended to provide a physical data base for internal dosimetry calculations. The principal calculations performed by EDISTR are the determination of (1) the average energy of beta particles in a beta transition, (2) the beta spectrum as function of energy, (3) the energies and intensities of x-rays and Auger electrons generated by radioactive decay processes, (4) the bremsstrahlung spectra accompanying beta decay and monoenergetic Auger and internal conversion electrons, and (5) the radiations accompanying spontaneous fission. This report discusses the theoretical and empirical methods used in EDISTR and also practical aspects of the computer implementation of the theory. Detailed instructions for preparing input data for the computer program are included, along with examples and discussion of the output data generated by EDISTR.

10927 (SLAC-PUB—2441) **Neutron production and leakage from medical electron accelerators.** McCall, R.C.; Swanson, W.P. (Stanford Linear Accelerator Center, CA (USA)). Dec 1979. Contract EY-76-C-04-0789. 4p. (CONF-800304—2). Dep. NTIS, PC A02/MF A01.

From 5. international congress of the International Radiation Protection Association; Jerusalem, Israel (8 Mar 1980).

For medical accelerators operating above about 10 MeV, there is an unavoidable production of photoneutrons which add to the head leakage. The yield of photoneutrons produced by electron beams incident on thick targets has been calculated and found to increase rapidly with primary electron energy up to approximately

25 MeV, and more slowly thereafter. Dividing the neutron fluence for W (or Pb) by the photon absorbed dose for the same conditions gives the ratio plotted. This ratio, representing the maximum achievable with practical materials, becomes nearly constant above about 25 MeV incident electron energy where its value is about 2.1 x 10^5 neutrons cm^{-2} rad^{-1}. Measurements that fall significantly below the curve are likely due to photon absorption in components that are not high-Z materials, or measurements made with the moveable jaws open. Points that fall significantly above probably mean there is substantial loss of electron beam elsewhere than the intended target.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 10330, 10908, 10923

10928 (DOE/TIC—11068) **Thermal motion analysis.** Johnson, C.K. (Oak Ridge National Lab., TN (USA)). 1980. Contract W-7405-ENG-26. 16p. Dep. NTIS, PC A02/MF A01.

This tutorial article was written for the 1980 Crystallographic Computing School and it is not a review article covering the world literature on thermal motion. The items selected for coverage reflect the author's viewpoint on what can be determined from thermal-motion studies using Bragg diffraction data. The emphasis is on rigid-body and segmented-body thermal-motion analysis, the effects of internal molecular vibration on vibration ellipsoids, and a practical model for anharmonic vibration analysis. A quasi-orthogonal model for higher-order atomic thermal motion is described which previously was unpublished. A least-squares program incorporating that model has been in use since 1971 and has a history of successful application to difficult problems such as ionic conductors, particularly by Reidinger (1979).

10929 (LBL—9334) **Experimental studies of excited metallic phases in stressed germanium.** Furneaux, J.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1979. Contract W-7405-ENG-48. 157p. Dep. NTIS, PC A08/MF A01.

Thesis.

The strain-confined electron-hole liquid (SCEHL) is a unique form of matter which forms when photoexcited carriers flow into a strain potential well created by suitably inhomogeneously stressing Ge. Various experimental aspects of this SCEHL were studied.

10930 Spin-echoes for diffusion in bounded, heterogeneous media: A numerical study. Zientara, G.P.; Freed, J.H. (Department of Chemistry, Cornell University, Ithaca, New York 14853). *J. Chem. Phys.;* **72**: No. 2, 1285-1292(15 Jan 1980).

The diffusive behavior of spin-bearing species in a bounded heterogeneous medium is analyzed in a manner appropriate for spin echo experiments in the presence of field gradients. A numerical method based upon the stochastic Liouville equation (SLE) is discussed that includes the discontinuities in transport and solubility properties due to the different spatial regions. The double step computational algorithm, which takes advantage of the different time scales of diffusive and spin-quantum phenomena, is then introduced as a general approximate solution of the time dependent SLE. This method is applied to the calculation of the decay of spin echo amplitudes, and it suggests a new approach for analyzing such experiments in terms of the microscopic details and chemical properties of heterogeneous systems.

10931 Quantum particle in one-dimensional potentials with incommensurate periods. Azbel, M.Y. (Bell Laboratories, Murray Hill, New Jersey 07974). EY-76-C-02-0016. *Phys. Rev. Lett.;* **43**: No. 26, 1954-1957(24 Dec 1979).

The energy spectrum and wave functions for a particle in periodic potentials with incommensurate periods are obtained analytically and reduced to specific phase trajectories. The spectrum is of the devil's-stairs type. States may be extended and localized, separated by mobility edges. These results are applicable to incommensurate linear chain structures (such as those in Hg/sub 3-delta/ AsF_6) and to the fine structure of de Haas—van Alphen oscillations.

10932 Computational algorithm for densities of states. Budgor, A.B.; Peterson, G. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 4847-4852(15 Dec 1979).

In this article we introduce the differential-area method for producing accurate phonon or electron density-of-states spectra. Its inherent advantages are that (1) the energy or frequency variable can be preset to any desired interval range; (2) no root-searching or gradient computations are required; (3) it is independent of any force model employed in deriving the matrix elements of a phonon-dynamical or electron-connectivity matrix; and (4) its numerical algorithm is totally crystal-symmetry independent. Model density-of-phonon-states calculations are performed for the next-nearest-neighbor cubic lattices and compared to an exact technique, the root surface method.

10933 Anisotropic contributions to the optical potential employed in theoretical treatments of electron spectroscopies. Rasolt, M.; Davis, H.L. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). W-7405-ENG-26. *Phys. Rev., B: Condens. Matter;* **20**: No. 12, 5059-5070(15 Dec 1979).

An analysis is presented which indicates that anisotropic contributions to the optical potential can be caused by the broken symmetry of a surface. This anisotropy is not related to surface plasmons and extends a few layers into the surface region. The anisotropic contributions have been estimated for a simple metal and shown to be of the same order of magnitude as the isotropic contributions. To test possible influences of the anisotropy, a model low-energy electron diffraction (LEED) calculation has been performed. Our results do not show major changes in the LEED I—V profiles, which serve to lend additional credence to previous LEED analyses in which isotropic optical potentials were used. However, it is pointed out that the anisotropic contributions could produce larger effects in other electron spectroscopies (e.g., photoemission).

10934 Coherent second-harmonic generation by counterpropagating surface plasmons. Chen, C.K.; deCastro, A.R.B.; Shen, Y.R. (Material and Molecular Research Division, Lawrence Berkeley Laboratory, and department of Physics, University of California, Berkeley, California 94720). W-7405-ENG-48. *Opt. Lett.;* **4**: No. 12, 393-394(Dec 1979).

We have observed second-harmonic generation by counter-propagating surface-plasmon waves. The output is in the form of a well-collimated beam along the surface normal. The results are in excellent agreement with theoretical prediction.

10935 Molecular dynamics of shock waves in three-dimensional solids: Transition from nonsteady to steady waves in perfect crystals and implications for the Rankine-Hugoniot conditions. Holian, B.L.; Straub, G.K. (Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **43**: No. 21, 1598-1600(19 Nov 1979).

Molecular-dynamics calculations of shock waves in perfect three-dimensional solids at nonzero initial temperatures reveal a transition in the nature of the asymptotic shock-wave structure as a function of shock strength. The key to this transition from nonsteady to steady waves where the Rankine-Hugoniot relations are obeyed is the partial relaxation of compressive shear stress behind the shock front which accompanies small, but permanent, transverse strains in atomic positions.

10936 Schottky and Bardeen limits for Schottky barriers. Cohen, M.L. (Department of Physics, University of California). *J. Vac. Sci. Technol.;* **16**: No. 5, 1135-1136(Sep 1979).

An estimate for the minimum (Bardeen limit) and maximum (Schottky limit) of the interface index, S, is calculated. It is shown that current measurements on high S materials are near or at the maximum value for S.

10937 Single-reflection layer-scattering theory of low energy electron diffraction spectra. Hjalmarson, H.P.; Dow, J.D.; Mrstik, B.J. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *J. Vac. Sci. Technol.;* **16**: No. 5, 1262-1265(Sep 1979).

A simple general method for computing medium and low energy electron diffraction (LEED) spectra of layered materials has been developed for application to transition metal dichalcogenides. Electron transmission and reflection coefficients for each individual sheet of atoms are computed; the separate sheets are grouped into sandwiches which are stacked upon one another to form the crystal; the intersheet scattering is treated with the single-reflection approximation. For an unrelaxed lattice whose sandwiches are separated by the distance b and whose intrasandwich layers are separated by a, the scattered electron intensity is vertical-bar f (a) vertical-bar ^{2} S (b), where f (a) is the single-sandwich form factor for the outermost sandwich. Lattice relaxation of the surface sandwich slightly modifies this result. The static structure factor S (b), which is a spiked function of energy and contains mainly bulk structural information, produces the principal peaks in the intensity versus energy spectrum, but the surface sandwich reflectivity vertical-bar f (a) vertical-bar ^{2} smoothly modulates the peak intensities and contains most of the surface structure information. This method of fitting vertical-bar f (a) vertical-bar ^{2} should be contrasted with most LEED analyses that concentrate on fitting peaks [which are related to S (b) and actually contain little surface structure information]. This simple single-reflection analysis of the surface structure is confirmed by a complete multiple scattering calculation.

10938 (110) surface of GaAs. Chelikowsky, J.R.; Cohen, M.L. (Department of Physics and Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). *J. Vac. Sci. Technol.;* **16**: No. 5, 1307(Sep 1979).

The electronic structure of GaAs(110) is analyzed by means of a surface relaxation model through low energy electron diffraction studies. (AIP)

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 10343, 10344, 10346, 10347, 10355, 10357, 10383

10939 (LA—8159-PR) **LASL Nb_3Ge conductor development. Thirteenth quarterly progress report, July 1-September 30, 1979.** Maley, M.P. (comp.). (Los Alamos Scientific Lab., NM (USA)). Dec 1979. Contract W-7405-ENG-36. 15p. Dep. NTIS, PC A02/MF A01.

The thirteenth quarterly progress report of the Los Alamos Scientific Laboratory program to develop Nb_3Ge as a superconductor with potential applications to superconducting power transmission lines covers the period July 1, - September 30, 1979. The completion of the first one-meter test section of Nb_3Ge-based superconducting power transmission line is reported. The shorted length of coaxial cable is constructed on the Brookhaven National Laboratory (BNL) double-helix design and consists of four separate layers of Nb_3Ge-coated tapes wound at angles near 45°. A total of 85 m of Nb_3Ge-coated tape was produced for this cable and only tapes which exhibited critical current density J/sub c/ at 14 K $\geqq$ 1.8 x 10^6 A/cm^2 were used in the fabrication. The results of efforts to improve J/sub c/ at high temperature by layering are described. Investigations of factors affecting material homogeneity in the long sample apparatus by x-ray and heat capacity studies were continued.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

REFER ALSO TO CITATION(S) 10820, 10821, 10931

10940 (ORO—3992-375) **Fiber bundles in non-relativistic quantum mechanics.** Moylan, P. (Texas Univ., Austin (USA). Center for Particle Theory). Nov 1979. Contract EY-76-S-05-3992. 43p. Dep. NTIS, PC A03/MF A01.

The problem of describing a quantum-mechanical system with symmetry by a fiber bundle is considered. The quantization of a fiber bundle is introduced. Fiber bundles for the Kepler problem and the rotator are constructed. The fiber bundle concept provides a new model for a physical system: it provides a model for an elementary particle with extension having integral values of spin. 5 figures.

10941 **Combinatorics, partitions, and many-body physics.** Polyzou, W.N. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *J. Math. Phys. (N.Y.),* **21**: No. 3, 506-513(Mar 1980).

Some combinatorial techniques are presented which streamline the graphical analysis used in N-body scattering theory. The basic results are derived using properties of the lattice of partitions of N particles, which naturally arises on classifying translational symmetry properties of N-body operators. Classical cumulant expansions are recovered, previously obtained results are presented from a unified point of view, and some new theorems concerning connectivity of N-body equations are presented.

10942 **Exactly soluble many channel scattering model.** Rohlfing, E.A.; Loeser, J.G.; DePristo, A.E.; Rabitz, H. (Department of Chemistry, Princeton University, Princeton, New Jersey 08544). *J. Chem. Phys.;* **72**: No. 1, 464-472(1 Jan 1980).

An exactly soluble model for many channel quantum scattering is presented which is a generalization of elastic scattering from a square radial potential. Through the appropriate choice of channel energies and couplings, as well as total energy and potential strength, this model is readily applicable to a wide variety of scattering problems. The relative simplicity of the calculations allows one to characterize a system easily in terms of the relevant collision parameters (basis set size, coupling strengths, etc.). Moreover,the analytic nature of the solutions enables one to interpret the results of such calculations directly. Two applications are presented which illustrate the capabilities of the model and demonstrate interesting scattering behavior.

10943 **Roundoff error in the Numerov algorithm.** Friar, J.L. (Los Alamos Scientific Lab., NM). *J. Comput. Phys.;* **28**: No. 3, 426-432(Sep 1978).

Roundoff error is investigated in solutions of the partial-wave Schroedinger's equation by Numerov's method. The uncommon summed form of the algorithm is shown to be superior in this regard and is recommended. Various details and analytic solutions are discussed. 2 figures.

RELATIVITY AND GRAVITATION

10944 **Equation of motion in classical electrodynamics. II.** Herrera, J.C. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **21**: No. 2, 384-387(15 Jan 1980).

With the aid of the principle of equivalence, we extend our development of an equation of motion for a radiating charged particle to include movement in both a gravitational and an electromagnetic field. The rate of electromagnetic radiation is given by the covariant generalization of the Larmor formula for flat space-time. The proposed equation of motion exhibits none of the difficulties that are associated with the covariant extension of the Lorentz-Dirac equation. We apply our results to the simple examples of a charged particle falling in a gravitational field and a charged particle held fixed in a quasiuniform gravitational field.

OPTICS

10945 **Interference-enhanced frustrated total internal reflection.** Hull, J.R.; Iles, M.K. (Energy and Mineral Resources Research Institute and Department of Physics, Iowa State University, Ames, Iowa 50011). *J. Opt. Soc. Am.;* **70**: No. 1, 17-28(Jan 1980).

When the reflected or transmitted field of a frustrated total internal reflection is returned along its path to the point of incidence, it produces a third auxiliary field. When any combination of two of the three fields is returned along their respective paths to the point of incidence, interference-enhanced frustrated total internal reflection (IEFTIR) occurs. Exact IEFTIR solutions are obtained for the case of two similar dielectric slabs separated by a dielectric gap. The general results include, for both s and p polarizations, the transmitted and reflected fields and the transmission and reflection coefficients for each of three possible modes. Special features of the solution are discussed regarding fast optical switching and variable transmission/reflection applications.

10946 **Optimum angle of incidence for monochromatic interference in transparent films on absorbing substrates.** Muller, R.H.; Sand, M.L. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemical Engineering, University of California, Berkeley, California 94720). *J. Opt. Soc. Am.;* **70**: No. 1, 93-97(Jan 1980).

Angles of incidence for s- and p-polarized light have been computed and confirmed experimentally for which monochromatic interference in transparent thin films on absorbing substrates results in optimum interference fringe contrast (visibility=1). Under these angles of incidence and with polarized light, film thickness determinations which are not possible at normal incidence or with unpolarized light can be carried out by use of thin-film interference.

10947 **Why is white light dispersed by a prism?.** Crawford, F.S. (Physics Department, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Teach.;* **17**: No. 9, 583-587(Dec 1979).

By consideration of the electric fields emitted by individual electron oscillators, the frequency dependence of the speed of light in glass in discussed. (AIP)

10948 **Polarization by gratings used at glazing incidence.** Arakawa, E.T. (Oak Ridge National Lab., TN); Williams, M.W.; Samson, J.A.R. *Appl. Opt.;* **17**: No. 16, 2502-2506(15 Aug 1978).

The polarization introduced by gold-coated and aluminum-coated concave reflection gratings used in a grazing incidence monochromator was measured over the spectral range from 20 nm to 130 nm. In every case the polarization ratio (P = R/sub p//R/sub s/) is greater than 0.8 for wavelengths less than 40 nm, and appears to be approaching unity below 20 nm. For both new and aged or contaminated gratings, the observed polarizations are consistent with those calculated by assuming reflection occurs at a plane thin multilayer region with the optical constants chosen to simulate the grating surface. 6 figures.

STATISTICAL PHYSICS AND THERMODYNAMICS

10949 (UCID—18305) **Power-law thermal model for blackbody sources.** Del Grande, N.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Oct 1979. Contract W-7405-ENG-48. 11p. Dep. NTIS, PC A02/MF A01.

The spectral radiant emittance W/sub E/ from a blackbody at a temperature kT for photons at energies E above the spectral peak (2.82144 kT) varies as (kT)/sup E/kT/. This power-law temperature dependence, an approximation of Planck's radiation law, may have applications for measuring the emissivity of sources emitting in the soft x-ray region.

10950 **WINIMAX approximation and its application to the thermal properties of a Debye lattice.** Lee, M.W.; Bigeleisen, J. (Savannah River Laboratory, E. I. du Pont de Nemours Co., Aiken, South Carolina 29801). *J. Chem. Phys.;* **72**: No. 2, 1084-1088(15 Jan 1980).

The WINIMAX method is used to expand the thermodynamic functions of a Debye oscillator in a finite series as a function of (θ/

sub D//T)/sup 2j/. The series is valid for all values of θ/sub D//T. Comparisons are made with the MINIMAX expansion, the Sack, Maradudin, and Weiss method and exact calculations. The WINIMAX method gives the exact value of each of the thermodynamic functions for any order polynomial.

10951 Commensurability in one-dimensional lattices at finite temperature. Sacco, J.E.; Widom, A.; Sokoloff, J.B. (Department of Physics, Northeastern University, Boston, Massachusetts). EG-77-S-02-4432. *J. Stat. Phys.;* **21**: No. 5, 497-516(Nov 1979).

The theory of commensurability transitions in one-dimensional atomic chains has been applied to charge density waves, mercury chain compounds, superionic conductors, etc. Previous numerical and analytical results on a model with chains of atoms with nearest neighbor interactions and periodic external potentials have dealt mainly with equilibrium and dynamical properties at T=0 K. These studies are extended to nonzero temperatures. It is found that the reversible work per particle to slide the chain vanishes in the thermodynamic limit for any nonzero temperature. The mathematical pathologies associated with the commensurability transition at T=0 (i.e., the "devil's stair") are absent at finite temperature; only thermodynamic evidence of low-order commensurability transitions remains.

10952 Possible conflict of J. Vac. Sci. Technol. 15, 1182 (1978) with the second law of thermodynamics. Edwards, D. Jr. (Brookhaven National Laboratory, Upton, New York 11973). *J. Vac. Sci. Technol.;* **16**: No. 5, 1573-1574(Sep 1979).

It is shown that two connected vessels at the same temperature, in equilibrium, may contain gases at different pressures without violating the second law of thermodynamics.(AIP)

ELECTRICITY AND MAGNETISM

REFER ALSO TO CITATION(S) 10944

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 10819, 10908

10953 (UCID—18499) **Nonlinear dynamics.** Garrison, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Nov 1979. Contract W-7405-ENG-48. 25p. Dep. NTIS, PC A02/MF A01.

The nonlinear dynamical equations that describe many important physical systems have to be solved by numerical methods; but numerical solutions are often difficult, if not impossible, to obtain without advance knowledge of some essential qualitative properties of the solution. Thus, analytical techniques to determine the required properties of the solution are an essential part of any satisfactory numerical method. This cursory survey of nonlinear physical phenomena describes some important problems and identifies common qualitative properties and analytical techniques. The principal defining characteristics of nonlinear dynamics are: bifurcation of solutions, symmetry breaking, multiple solutions and sensitivity to initial conditions. Brief descriptions of the following fields containing nonlinear problems are presented: nonequilibrium thermodynamics, turbulence, plasma physics, nonlinear optics, and nonlinear mechanics. The report concludes with general remarks on the similarities that exist between such apparently unrelated fields. (RWR)

10954 Automated computation of modified equations. Cloutman, L.D.; Fullerton, L.W. (Los Alamos Scientific Lab., NM). *J. Comput. Phys.;* **29**: No. 1, 141-144(Oct 1978).

The calculation of the modified equation has proved to be a valuable aid in assessing the accuracy and stability of a given difference equation. The technique consists of expanding the difference equation in a Taylor series about some suitably chosen expansion center. The result is a differential equation, the so-called modified equation, and consists of the original differential equation that is modeled by the difference equation plus truncation error terms. This note describes two ALTRAN programs for nonlinear systems. The first program performs the Taylor series expansion for a single difference equation in two independent variables, and the modified equation is produced as input for the second program. The second program eliminates time derivatives from the truncation error terms. The resulting equation can be examined for undesirable properties, such as errors of negative order. A typical application in fluid dynamics is given. (RWR)

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 10993

10955 (PPPL—1624) **Current generation with low-frequency waves.** Fisch, N.J.; Karney, C.F.F. (Princeton Univ., NJ (USA). Plasma Physics Lab.). Dec 1979. Contract EY-76-C-02-3073. 58p. Dep. NTIS, PC A04/MF A01.

Various types of traveling waves may be injected into a tokamak to continuously sustain the toroidal current. Interest in this problem arises from the possibility of operating tokamak reactors in the steady state. The low-frequency waves most suitable for this task are identified in terms of the power cost for deployment in a reactor. Means of exciting these waves and tradeoffs with design criteria are discussed. A comparison is made with the alternative attractive regime of high-frequency waves. Conclusions are based, in part, on the numerical solution of the two-dimensional Fokker-Planck equation with an added quasilinear term due to the waves.

10956 Plasma heating by an intense relativistic electron beam: An experimental study. Greenspan, M.A.; Ekdahl, C.; Sethian, J.D.; Wharton, C.B. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **23**: No. 1, 205-219(Jan 1980).

A 3—20 kA, 300—350 kV, 60 nsec electron beam has been axially injected through various anode foils into a 1.6 m long, mirror confined, fully ionized hydrogen plasma, with an initial plasma density variable from 5 x 10^{11}/cm^3 to 2 x 10^{13}/cm^3. Beam propagation and total plasma heating were studied, and special studies were done of return current heating and direct ion heating by the beam. Total energy deposition efficiencies of 4%—30% were observed. Variations with parameters showed stronger heating with thinner anode foils and good agreement with theoretical predictions based on beam energy loss by trapping in the unstable waves generated by the two-stream instability. Return current heating was found to be only 10%—20% of the total heating for beam-to-plasma density ratios $<$ or $=0.02$. Anomalous plasma resistivity was observed in all cases; the use of a thinner anode foil strongly increased this resistivity during the beam, probably due to anomalous resistivity induced by the two-stream instability. Rapid ion heating was observed and inferred to be primarily by the return current interaction, by anomalous electron-ion energy transfer, and by radial electrostatic fields induced by the beam.

10957 Minimum energy state of a toroidal discharge. Reiman, A. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Phys. Fluids;* **23**: No. 1, 230-231(Jan 1980).

Previous analysis of the relaxation of a toroidal discharge used an incorrect expression for the energy of a force-free state. Although the primary conclusions remain essentially unchanged, the analysis using the correct expression is considerably different in some respects.

10958 Formation of thermal eddies during rf heating of plasma. Motley, R.W.; Hooke, W.M.; Anania, G. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *Phys. Rev. Lett.;* **43**: No. 24, 1799-1802(10 Dec 1979).

Moderate-power ($\sim$ 1 kW) excitation of lower-hybrid waves in a linear plasma column is found to increase the reflectivity of the phased waveguide exciter and to change the vertical position of the resonance cone. Probing of the plasma near the mouth of the waveguide reveals that the increased reflection results from an undulation in the plasma surface. We present evidence that this surface distortion is driven by thermal eddies associated with asymmetrical electron heating.

10959 Fast-wave heating of two-ion plasmas in the Princeton large torus through minority-cyclotron-resonance damping. Hosea, J.; Bernabei, S.; Colestock, P.; Davis, S.L.; Efthimion, P.; Goldston, R.J.; Hwang, D.; Medley, S.S.; Mueller, D.; Strachan, J.; Thompson, H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). EY-76-C-02-3073. *Phys. Rev. Lett.;* **43**: No. 24, 1802-1806(10 Dec 1979).

Strong minority proton heating is produced in PLT through ion cyclotron resonance damping of fast waves at moderate rf power levels. In addition to demonstrating good proton confinement, the proton energy distribution is consistent with Fokker-Planck theory which provides the prescription for extrapolation of this heating regime to higher rf power levels and other minority species.

10960 Analytical representation and physics of ballooning modes. Coopi, B.; Filreis, F.; Pegoraro, F. (Massachusetts Institute of Technology, Cambridge, Massachusetts). *Ann. Phys. (N.Y.);* **121**: No. 1, 1-31(1 Sep 1979).

The topological and physical characteristics of the modes that can be excited in magnetically confined plasmas, with two-dimensional equilibrium configurations, are recognized. In particular, a direct three-dimensional representation of the modes that are typical of axisymmetric toroidal configurations is given on the basis of their general symmetry properties and, from this, the critical pressure gradient for their onset in the "ideal MHD approximation" can be evaluated. These modes are driven by the locally unfavorable magnetic curvature over an interval of a given field line where the mode amplitude is largest, and since the plasma is constrained to move with the magnetic field, they can be excited only when the plasma pressure becomes a finite fraction of the magnetic pressure. Other modes, that are topologically similar but exist for lower values of the plasma pressure relative to the magnetic pressure, are found when dissipative or velocity space effects are taken into account. From the topology point of view, it is pointed out that the so-called "disconnected-mode" description of ballooning modes which have strongly varying amplitude over a given field line, is adequate in most cases of interest. In fact, "disconnected" modes act on successive periodically spaced intervals of a given field line as if these were independent of each other. The disconnecting property is related to the effects of magnetic shear.

PLASMA DIAGNOSTICS

10961 (LA—8117-MS) **Ultra-soft x-ray light pipes for space-, time-, and energy-resolved imaging of high-density plasmas.** Ekdahl, C.A. (Los Alamos Scientific Lab., NM (USA)). Nov 1979. Contract W-7405-ENG-36. 21p. Dep. NTIS, PC A02/MF A01.

By use of the Ultra-Soft X-ray (USXR) analog of "light-pipes" it is possible to obtain space- and time-resolved measurements of plasma radiation in the high-energy region of the emission spectrum. Using fast analog-to-digital converters, computerized data acquisition and processing, and the techniques of computer-aided tomography, it is possible to reconstruct from these data the time evolution of a spatially distributed x-ray source. A conceptual design of an apparatus using USXR pipes for obtaining spatially resolved data from the ZT-40 toroidal pinch is described. The pipes also have the property of acting as a dispersing element, and a means of using this feature to obtain information about the spectral properties of the plasma source is described.

10962 (UCRL—52000-79-8, pp 17-25) **Diagnostic instruments for mirror-confined fusion plasmas.** Aug 1979.

In Energy and technology review.

Diagnostic techniques that are used in the 2XIIB and TMX experiments are briefly described. These include the following; neutron detector and reaction-ion analyzer, charge-exchange analyzer, Thomson scattering, microwave interferometer, diamagnetic loop, neutral-beam attenuation detector, x-ray detector, rf probe, neutral beam calorimeter, electrostatic end-loss analyzer, uv spectrometer, and ion beam probes. (MOW)

10963 **Elmo Bumpy Torus heavy ion probe.** Bieniosek, F.M.; Colestock, P.L.; Connor, K.A.; Hickok, R.L.; Kuo, S.P.; Dandl, R.A. (Rensselaer Polytechnic Institute, Troy, New York 12180). *Rev. Sci. Instrum.;* **51**: No. 2, 206-212(Feb 1980).

A diagnostic system based on the heavy ion beam probe technique has been developed for the Elmo Bumpy Torus. A variety of singly charged alkali metal ions have been used in the probing beam; detection of multiply charged reaction products allows a continuous spatially resolved monitor of the plasma space potential. Typical spatial resolution is 1 cm^{-3}; time resolution is on the order of 1 s. The potential measurement is direct and properly referenced to the plasma ground. An investigation into possible sources of error in the measurement points to the conclusion that the uncertainty is an order of magnitude less than the experimentally measured potentials.

10964 **Electron density measurement by deflection of a far-infrared beam.** Keren, H.; Hirshfield, J.L. (Department of Engineering and Applied Science, Yale University, New Haven, Connecticut 06520). *Appl. Phys. Lett.;* **36**: No. 2, 128-130(15 Jan 1980).

Electron densities in the range 3 x 10^{14} <N/sub e/ < 6 x 10^{1} cm^{-3} have been determined in a laser-initiated linear discharge using a novel far-infrared method. The density was determined by measuring deflections of a 119- and 171-μm far-infrared beam from an optically pumped CH_3OH laser. The far-infrared beam was guided both inside and outside of the plasma chamber using dielectric waveguides. The spatial distribution of electron density for peak discharge currents of 2—4 kA and at distances of 8—25 mm from the laser focus on the target was found to be given by N/sub e/ $(r,\theta,I) = 3 \times 10^{14} I/sup\ 1.9/r/sup\ -2.4/\ cos\omega\ cm^{-3}$, where I is the discharge current in kA, r is the radius from the laser focus on the target in cm, and θ is the polar angle from the target axis.

10965 **Spatial imaging detector system for pulsed plasma extreme ultraviolet diagnostics.** Richards, R.K.; Moos, H.W.; Allen, S.L. (Department of Physics, The Johns Hopkins University, Baltimore Maryland 21218). *Rev. Sci. Instrum.;* **51**: No. 1, 1-7(Jan 1980).

A spectroscopic instrumentation system is described which forms one-dimensional monochromatic EUV images of pulsed plasma sources. The system uses a small monochromator and a 22 anode microchannel plate detector to simultaneously view 22 chords of the plasma at the wavelength of a given impurity emission with 100 μs resolution. Brightness profiles are measured and stored in a minicomputer at up to 400 time points during a single discharge. If the discharge is cylindrically symmetric, this data can be Abel inverted directly to produce the volume emission rates and impurity density profiles during the discharge. The design, construction, and testing of the system are described, as well as its performance on the Alcator A tokamak.

PLASMA KINETICS - GENERAL

10966 (N—79-18762) **Experimental and theoretical work in plasma physics. Annual status report, 31 dec. 1977.** (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Jul 1978. 89p. NTIS PC A05/MF A01.

Areas of plasma physics investigated include magnetohydrodynamics, wave dynamics, transport phenomena, quantum mechanical methods, and fusion reactor problems. Experimentation is reported in pinches, turbulent heating, gas blanket research, and diagnostics. Long term planning of the European fusion program and construction of the joint European torus, are discussed. The reconstruction of the RINGBOOG device to make possible four types of discharges is described, as well as the design of TORTUR for the turbulent heating experiments.

PLASMA KINETICS - THEORETICAL

REFER ALSO TO CITATION(S) 10993

10967 (AD-A—070476) **Plasma multistreaming and the viability of fluid codes.** Manheimer, W.M.; Lampe, M.; Clark, R.; Chu, K.R.; Liewer, P.C. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1976. Contracts N00014-75-C-0309;N00014-67-A-0239. 34p. NTIS PC A03/MF A01.

For plasmas in the collisionless regime, the absence of bulk viscosity permits multistreaming; if this occurs, fluid codes, which by definition prohibit multistreaming, give unphysical results. We show that a fluid code, using an energy propagation equation, will conserve energy but nevertheless can give totally incorrect results if multistreaming occurs. If a temperature propagation equation is used instead, the system continuously loses energy when multistreaming occurs. This energy nonconservation, which is completely independent of cell size and time step, can be used as an internal test for multistreaming, requiring no data outside the fluid code itself.

10968 (AD-A—070477) **Solution of coupled rate equations and prediction of time histories of emission lines in a rapidly ionizing plasma.** Datla, R.U. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1976. Contracts N00014-75-C-0309;N00014-67-A-0239. 75p. NTIS PC A04/MF A01.

The time histories of emission lines from successive ionization stages of impurity atoms in a plasma are predicted by solving the coupled rate equations governing the populations of these ionization stages with the help of a computer program. A detailed description of the program is given. An application of such predictions for the measurement of ionization rate coefficients of ions occurring in a rapidly ionizing plasma is discussed.

10969 (AD-A—070478) **Vlasov equilibria for a warm finite radius rotating relativistic electron beam in a magnetized plasma.** Ottinger, P.F.; Guillory, J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1977. Contracts N00014-75-C-0309;N00014-67-A-0239. 46p. NTIS PC A03/MF A01.

A Vlasov equilibrium model is developed which can describe a broad class of beam-plasma systems in an applied field, B O sub z. The model treats arbitrary density profiles and azimuthal self-magnetic fields as well as a thermal spread in the momentum of the beam. It is assumed that the electron gyroradius is small but not negligible compared with the beam radius, and that the beam is completely charge neutralized but only fractionally current neutralized. The electron orbit equations are solved and are used to simplify the form of the distribution function and the calculation of its velocity moments. The rotation frequency of the beam and the diamagnetic or paramagnetic properties of such warm beam-plasma systems are also studied.

10970 (AD-A—070481) **Axially-dependent equilibrium of an unneutralized electron beam in an axial magnetic field.** Guillory, J. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1977. Contracts N00014-75-C-0309;N00014-67-A-0239. 22p. NTIS PC A02/MF A01.

Axially-dependent Vlasov-Poisson equilibria are studied for monoenergetic unneutralized electron beams injected along magnetic field lines into a vacuum half-space and partially or totally

reflected by the beam space charge. For simplicity, the entering beam electrons are assumed to be nonrelativistic and to have a rectangular distribution in momentum pitch angles with respect to the magnetic field. Electron density at any point along a field line is first expressed in terms of a potential for parallel motion (assuming conservation of magnetic moment), and this is then substituted into Poisson's equation to obtain a nonlinear partial differential equation for the space charge potential. The one-dimensional problem, in which only axial electric fields are considered, is reduced to quadrature and an exact solution is obtained in the singular case where the beam has no spread in pitch angles. The two-dimensional problem, in which radial electric fields transfer energy from the axial streaming motion to azimuthal ExB rotation to assist the axial reflection, has been reduced to a nonlinear partial differential suitable for computational solution.

10971 (LA-UR—79-3396) **Compact torus theory: MHD equilibrium and stability.** Barnes, D.C.; Seyler, C.E.; Anderson, D.V. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 6p. (CONF-791225—2). Dep. NTIS, PC A02/MF A01.

From Symposium on compact toruses and energetic particle injection; Princeton, NJ, USA (11 Dec 1979).

Field reversed theta pinches have demonstrated the production and confinement of compact toroidal configurations with surprisingly good MHD stability. In these observations, the plasma is either lost by diffusion or by the loss of the applied field or is disrupted by an n = 2 (where n is the toroidal mode number) rotating instability only after 30 to 100 MHD times, when the configuration begins to rotate rigidly above a critical speed. These experiments have led one to investigate the equilibrium, stability, and rotation of a very elongated, toroidally axisymmetric configuration with no toroidal field. Many of the above observations are explained by recent results of these investigations which are summarized.

10972 (LA-UR—79-3397) **Relaxation of toroidal discharges.** Turner, L. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-791225—3). Dep. NTIS, PC A02/MF A01.

From Symposium on compact toruses and energetic particle injection; Princeton, NJ, USA (11 Dec 1979).

The variational principle of Taylor provides the guiding spirit for calculations concerning the relaxation of turbulent plasma discharges. The principle states that a turbulent, high-magnetic-Reynolds-number plasma confined by a perfectly conducting shell will achieve the state of minimum magnetic energy consistent with specified magnetic helicity and magnetic flux. It yields the Euler equation vector V x vector B = lambda vector B where, for reversed-field pinch geometries, the eigenvalue lambda is a continuous variable that specifies the ratio of net toroidal current to net toroidal magnetic flux. Although this principle has not as yet received rigorous justification, it has been able to reproduce much of the gross experimental features of the British reversed-field pinch experiment ZETA. Some observations are described. (MOW)

10973 (N—79-18760) **The neutral density in a hydrogen arc.** Goedheer, W.J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Inst. voor Plasma-Fysica). Sep 1978. 48p. NTIS PC A03/MF A01.

A method to calculate the neutral density in a hydrogen plasma by means of a reduced set of rate equations is presented. The plasma is assumed to be optically thin, so that the only radiative transitions are spontaneous de-excitation and radiative recombination. In the collisional transitions, only interaction with electrons is considered. The method is described and applied to a hydrogen arc. The influence of deviations from local thermodynamic equilibrium on the temperature and pressure profiles of an infinitely long cylindrically symmetric hydrogen arc with an externally applied axial magnetic field is studied.

10974 **Higher-order Chapman—Enskog theory for electrons.** Hassam, A.B. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **23**: No. 1, 38-43(Jan 1980).

Fluid equations for electrons are obtained correct to second order in the inverse of the collision frequency by employing a Chapman—Enskog-type expansion. These equations are an order more accurate than those of Braginskii, and should be especially useful for physical situations, linear and nonlinear, in which the electrons behave adiabatically.

10975 **Guiding center plasma with gravitational or gradient drifts.** Joyce, G.; Liu, C.S.; Montgomery, D. (Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242). *Phys. Fluids;* **23**: No. 1, 82-90(Jan 1980).

Theory and simulation are presented for the two-dimensional electrostatic guiding center plasma in a uniform gravitational field. It is shown that the gravitational field leads to large electrostatic energies at long wavelengths and associated vortex motion in the plasma.

10976 **Effect of density plateau on inverse bremsstrahlung.** Mitrovich, D. (KMS Fusion, Inc., Ann Arbor, Michigan 48106). *Phys. Fluids;* **23**: No. 1, 200-204(Jan 1980).

In a spherically symmetric, steady-state, isothermal expanding plasma, the near-critical density plateau that can arise from the ponderomotive force of incident radiation can affect the various absorption mechamisms. The inverse bremsstrahlung process is calculated here and it is shown that, for representative cases, the net absorptivity is little influenced by the existence of the plateau.

10977 **Superbanana orbits in stellarator geometries.** Derr, J.A.; Shohet, J.L. (The University of Wisconsin, Madison, Wisconsin 53706). ET-78-S-02-5069. *Phys. Rev. Lett.;* **43**: No. 23, 1730-1733(3 Dec 1979).

The presence of superbanana orbits localized to either the interior or the exterior of classical stellarators and torsatrons is investigated for 3.5 MeV alpha particles. The absence of the interior superbanana in both geometries is found to be related to nonconservation of the action. Exterior superbananas are found in the stellarator only, as a consequence of the existence of absolute localized magnetic wells. No superbananas of either type are found in the torsatron.

10978 **Particle diffusion by magnetic perturbations of axisymmetric geometries.** Mynick, H.E.; Krommes, J.A. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Rev. Lett.;* **43**: No. 20, 1506-1509(12 Nov 1979).

The quasilinear theory of collisionless test particle diffusion in stochastic magnetic fields is extended to include the effects of finite gyroradius, particle drifts, and magnetic trapping. Runaway-electron confinement is substantially improved relative to earlier estimates which assumed that particles exactly followed field lines. Trapped particles are not expected to be stochastic.

PLASMA PRODUCTION

10979 **Surface trapping of primary electrons by multidipole magnetic fields.** Hershkowitz, N.; DeKock, J.R.; Coakley, P.; Cartier, S.L. (Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242). *Rev. Sci. Instrum.;* **51**: No. 1, 64-69(Jan 1980).

Multidipole plasma devices are operated in an unconventional manner with primary electrons prevented by surface magnetic fields from entering the main plasma volume. Applications of this technique, to provide primary electron-free unmagnetized plasmas and to furnish a source for a large diameter magnetized plasma column, are given.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 10960, 10971, 10992

10980 (AD-A—070475) **Instabilities in a magnetized beam-plasma system. Technical report.** Ottinger, P.F. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1976. Contracts N00014-75-C-0309;N00014-67-A-0239. 24p. NTIS PC A02/MF A01.

A review of the existing theory on instabilities in a magnetized beam-plasma system is presented with emphasis on the unstable electromagnetic waves in the frequency range between ion cyclotron frequency and the electron cyclotron frequency. The strengths and weaknesses of the various theoretical models are discussed and it is pointed out in which direction future work should proceed. Both the unbounded and radially bounded problems are considered, using both a quasistatic treatment and a fully electromagnetic treatment. Plots of the dispersion curves and a table of the quasistatic growth rates for four of the instabilities are given for reference.

10981 (AD-A—070479) **Influence of strong self electric fields on the ion resonance instability in a nonneutral plasma column.** Davidson, R.C. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1977. Contracts N00014-75-C-0309;N00014-67-A-0239. 39p. NTIS PC A03/MF A01.

The influence of strong self-electric fields on the ion resonance instability is examined for a cylindrical nonneutral plasma column immersed in a uniform axial magnetic field (B sub 0) (e sub z). The analysis is carried out within the framework of a macroscopic cold-fluid model, and electrostatic stability properties are investigated for the case of rectangular electron and ion density profiles. An important conclusion of this study is that the equilibrium self-electric field can have a large influence on stability behavior. Moreover, for a nonneutral plasma column with significant charge neutralization, it is found that the fundamental mode (l=1) is not the most unstable mode. Rather, higher harmonic perturbations have larger growth rates.

10982 (AD-A—070480) **Influence of finite ion larmor radius effects on the ion resonance instability in a nonneutral plasma column.**

Davidson, R.C.; Uhm, H. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1977. Contracts N00014-75-C-0309;N00014-67-A-0239. 52p. NTIS PC A04/MF A01.

This paper investigates the influence of finite ion Larmor radius effects on the ion resonance instability in a nonneutral plasma column aligned parallel to a uniform axial magnetic field (B sub 0) (e sub z). The analysis is carried out within the framework of a hybrid Vlasov-fluid model in which the ions are described by the Vlasov equation and the electrons are described as a macroscopic, cold fluid. Electrostatic stability properties are calculated for the case in which the equilibrium electron and ion density profiles are rectangular and the ion distribution function is specified. The resulting eigenvalue equation for the perturbed electrostatic potential is solved exactly to give a closed algebraic dispersion relation. This dispersion relation is solved numerically, and it is shown that the growth rate of the ion resonance instability exhibits a sensitive dependence on plasma parameters. For example, finite ion Larmor radius effects can have a strong stabilizing influence for azimuthal mode numbers l > or = 2, particularly when the equilibrium self electric field is sufficiently weak. For the fundamental mode (l=1), however, stability properties are identical to those calculated from a macroscopic two-fluid model, and the growth rate is unaffected by the value of ion Larmor radius.

10983 (AD-A—070482) **Intense microwave generation by the negative-mass instability.** Uhm, H.; Davidson, R.C. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1978. Contracts N00014-75-C-0309;N00014-67-A-0239. 25p. NTIS PC A02/MF A01.

This paper examines the negative-mass stability properties of an E-layer for transverse electric (TE) and transverse magnetic (TM) waveguide modes in a conducting cylinder. The analysis is carried out for a relativistic nonneutral E-layer aligned parallel to a uniform axial magnetic field (B sub 0) (e sub z), within the context of the assumptions that the electron motion is ultrarelativistic (gamma sub zero >> 1) and that cube rt (nu/gamma sub zero) << 1, where nu is Budker's parameter and gamma sub zero mc squared is the electron energy. One of the most important features of the analysis is that the axial energy spread can have a large influence of stability behavior for both the TE and TM waveguide modes. By appropriate choice of system parameters, it is shown that the spectrum of microwave radiation generated by the negative-mass instability can be very narrow-band.

10984 (AD-A—070483) **Plasma convection instability in an inhomogeneous magnetic field.** Ottinger, P.; Guillory, J.; Lashinsky, H. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1977. Contracts N00014-75-C-0309;N00014-67-A-0239. 37p. NTIS PC A03/MF A01.

A convection instability characteristic of plasmas in an inhomogeneous azimuthal magnetic field is treated in the linear stage and in nonlinear saturation. The analysis is done in such a way that collisional and collisionless limits can be taken, and these limits are displayed along with the more general intermediate result. The instability, known previously in the literature in its collision-dominated form, is shown to be a 'flute' instability with collisional modifications to the growth rate. The nonlinear saturation is analyzed by examining a finite amplitude restoring-force term in the differential equation that describes the instability. This term is due to the fact that the instability convects plasma into striations of the plasma column surface, modifyng the density gradient until the restoring forces balance the pressure gradient driving force. The effects of finite ion gyroradius are displayed, and applications of this study to convection cells in a thermal plasma and to exploding wire plasmas are discussed.

10985 (AD-A—070484) **Influence of axial energy spread on the negative-mass instability in a relativistic nonneutral E-layer.** Uhm, H.; Davidson, R.C. (Maryland Univ., College Park (USA). Dept. of Physics and Astronomy). 1978. Contracts N00014-75-C-0309;N00014-67-A-0239. 33p. NTIS PC A03/MF A01.

This paper investigates the influence of an axial energy spread on the negative-mass instability in a relativistic nonneutral E-layer aligned parallel to a uniform axial magnetic field (B sub 0)(e sub z). The stability analysis is carried out within the framework of the linearized Vlasov-Maxwell equations. It is assumed that the E-layer is thin with radial thickness much smaller than the mean radius and that nu gamma sub 0 << 1, where nu is Budker's parameter and gamma sub 0 mc-squared is the mean electron energy. Stability properties are investigated for the choice of electron distribution function in which all electrons have the same value of canonical angular momentum and a step-function distribution in axial momentum p sub z. The negative-mass growth rate is calculated including the important stabilizing influence of axial energy spread, and it is shown that modest energy spread is sufficient to stabilize perturbations with axial wavenumber.

10986 Nonlinear kink instabilities in tokamaks surrounded by force-free fields. Lui, H.C. (Plasma Physics Laboratory, Columbia University, New York, New York 10027). *Phys. Fluids;* **23**: No. 1, 153-157(Jan 1980).

The theory of Pao for the nonlinear behavior of linearly unstable kink modes in a sharp boundary plasma surrounded by a vacuum is extended to include force-free and distributed plasma currents. Nonlinear stabilization of the external kink (m=1) instability by force-free fields is enhanced by increasing the force-free current up to an optimum value. For fixed force-free currents, nonlinear kink stability is decreased by increasing the distributed plasma current. In general, the optimum force-free current increases as the plasma current increases. A condition to determine the nonlinear kink stability is derived by a perturbational method for long wavelength perturbations.

10987 Impurity effects on ion-drift-wave eigenmodes in a sheared magnetic field. Tang, W.M.; White, R.B.; Guzdar, P.N. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Fluids;* **23**: No. 1, 167-173(Jan 1980).

The stability of ion-drift-wave eigenmodes in a slab geometry with a sheared magnetic field is investigated. It is found that in contrast to the case of universal and dissipative electron-drift-wave eigenmodes, unstable impurity-driven normal modes can appear if specific conditions are satisfied. In addition, the influence of impurities on unstable ion-temperature-gradient-driven drift eigenmodes is also studied. It is found that, if their density profile is inwardly peaked, the impurities can exert a strong stabilizing influence on these modes.

10988 Note on the ballooning criterion for multipoles. Adler, E.A.; Lee, Y.C. (Department of Physics, University of California at Los Angeles, Los Angeles, California 90024). *Phys. Fluids;* **23**: No. 1, 228-230(Jan 1980).

An equation giving the critical pressure gradient for stability to ballooning modes is derived directly from the energy principle by specializing to displacements that do no bulk compression.

PLASMA WAVE PHENOMENA

REFER ALSO TO CITATION(S) 10958, 10959, 10976

10989 Effect of convective loss on the parametric decay of cold electron plasma waves. Wong, K.L.; Wilson, J.R.; Porkolab, M. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Phys. Fluids;* **23**: No. 1, 96-104(Jan 1980).

The resonant decay of cold electron plasma waves was investigated in the Princeton L-3 device in an argon plasma with $n \sim 10^{10}$—10^{11} cm^{-3}, B~700 G—2 kG, $f_0 \sim 50$—80 MHz ($\omega_0 >$ or $= 10\ \omega/$sub l/h). The decay waves were identified to be ion-acoustic waves and cold electron plasma waves. Because of convective losses in the finite extent pump field, the threshold for parametric decay is considerably higher than the collisional threshold for the dominant E/sub 0perpendicular/ x B coupling. Coupling due to E/sub 0parallel/ can be important in low density, high magnetic field plasmas. At high densities ($n > 3 \times 10^{10}$ cm^{-3}), E/sub 0perpendicular/ x B coupling becomes dominant. The E/sub 0perpendicular/ x B decay convective threshold was measured at various antenna lengths, magnetic field strengths, and plasma densities. The experimental results are in good agreement with theory. Indication of pump depletion and enchanced Landau heating of electrons were observed in the parametric decay process.

10990 Free and forced m=0 oscillations of a sharp-boundary Vlasov-fluid screw pinch. Cayton, T.E.; Lewis, H.R. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Fluids;* **23**: No. 1, 109-128(Jan 1980).

A dispersion differential equation is derived from the linearized equations of the Vlasov-fluid model for a sharp-boundary screw pinch using a very general fast-gyration, small-gyroradius ordering for the ions. Analytic solutions of the dispersion differential equation are obtained. The influence of finite ion gyroradius effects on both free and forced, azimuthally symmetric, small-amplitude oscillations of the plasma column is studied, and the results are compared and contrasted with the asymptotic guiding center plasma description. The forced oscillations are considered for frequencies at and below the first magnetoacoustic resonance. Small, but finite, ion gyroradii can influence the absorption of resonant magnetoacoustic oscillations strongly.

10991 Surface modes in magnetized fully ionized plasma. Waldron, W.L.; Shohet, J.L.; Hopps, J.H. (The University of Wisconsin, Madison, Wisconsin 53706). *Phys. Fluids;* **23**: No. 1, 129-138(Jan 1980).

Density fluctuations in a semi-infinite fully ionized plasma in the presence of a uniform magnetic field are investigated using a direct variational principle. "Two-stream" distribution functions are included to allow for the expected discontinuity in velocity space at the boundary. The microscopic boundary conditions incorporate both specular reflection and diffuse scattering effects. The shape of

the density fluctuation spectrum is very dependent on the orientation of the wave vector (k) with respect to the direction of the magnetic field. The spectrum also shows evidence of both ion and electron surface effects which become enhanced with the increase in diffuse scattering contributions at the boundary.

10992 Stability of temperature gradient drift-wave eigenmodes in sheared magnetic field. Chang, C.L.; Liu, C.S. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **23**: No. 1, 227-228(Jan 1980).

It is shown that roots of an eigenvalue equation for the electron temperature gradient drift mode in a collisionless plasma in a sheared magnetic field are stable.

10993 Hamiltonian theory of ponderomotive effects of an electromagnetic wave in a nonuniform magnetic field. Grebogi, C.; Kaufman, A.N.; Littlejohn, R.G. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). W-7405-ENG-48. *Phys. Rev. Lett.;* **43**: No. 22, 1668-1671(26 Nov 1979).

Noncanonical variables are used to construct a Hamiltonian for guiding-center motion in a nonuniform magnetostatic field. Lie methods are then used to obtain the ponderomotive (quasistatic) Hamiltonian for the perturbation by a wave of arbitrary polarization and wavenumber, with spatially modulated amplitude and wavevector. The result is applied to the problem of r.f. stoppering in mirror confinement.

10994 Saturation of Brillouin backscatter. Herbst, M.J.; Clayton, C.E.; Chen, F.F. (University of California, Los Angeles, California 90024). EY-76-5-03-0034. *Phys. Rev. Lett.;* **43**: No. 21, 1591-1595(19 Nov 1979).

Saturation of Brillouin backscatter is observed from underdense plasma targets with CO_2 laser intensities as low as 2 x 10^{11} W/cm^2. Maximum reflectivity is about 5%, implying an ion-wave amplitude of 1%. The most likely limiting mechanism is found to be ion trapping, which is effective at our low T/sub e//T/sub i/ ratio.

10995 Contribution of autoionization to total ionization rates. Cowan, R.D.; Mann, J.B. (University of California, Los Alamos Scientific Laboratory). *Astrophys. J.;* **232**: No. 3, 940-947(15 Sep 1979).

Electron impact collisions with ground-state ions in a low-density plasma may cause ionization either by direct ejection of an electron from the ion, or by excitation of an inner-subshell electron to an autoionizing level. We investigate the importance of the indirect process in sodium-like Fe XVI by means of detailed calculations of excitation cross sections and of branching ratios for autoionization versus radiative decay; the estimated accuracy is about 20%. We find that radiative decay reduces the autoionization rate (at kT=300—500 eV) to only about 52% of the excitation rate; even so, the indirect ionization rate is about 1.4—1.6 times the direct ionization rate in this temperature range. The relative importance of indirect to direct ionization is approximately as great for Na-like Mo XXXII as for Fe XVI, but should be much smaller for most nonalkali-like ions except Cu-like, Zn-like, and perhaps Ga-like ions.

FUSION POWER PLANT TECHNOLOGY

10996 (COO—5070-1) **TOREX-4: a torsatron proof of principle experiment.** Politzer, P.A.; Lidsky, L.M.; Montgomery, D.B. (Massachusetts Inst. of Tech., Cambridge (USA). Plasma Fusion Center). Mar 1979. Contract ET-78-S-02-5070. 158p. Dep. NTIS, PC A08/MF A01.

TOREX-4 is a torsatron Proof of Principle experiment designed to simultaneously achieve ntau approx. = to 5 x 10^{13}, n ≃ to 5 x 10^{14}/cm^3, and T ≧ 1 keV. TOREX-4 is capable of operating without externally driven currents; sufficient neutral beam power to reach betas of 2 to 5% is provided. The unique 4(+2) constant pitch angle winding configuration allows the reliable design of large systems with far greater experimental flexibility than can be achieved in conventional stellarators of comparable size. This will allow investigation of the basic physics questions of the torsatron configuration over a wide range of plasma properties and field configurations without sacrifice of the Proof of Principle goals. (MOW)

10997 (LA-UR—79-3395) **FRX-C and multiple-cell experiments.** Siemon, R.E. (Los Alamos Scientific Lab., NM (USA)). 1979. Contract W-7405-ENG-36. 5p. (CONF-791225—1). Dep. NTIS, PC A02/MF A01.

From Symposium on compact toruses and energetic particle injection; Princeton, NJ, USA (11 Dec 1979).

Two new compact torus experiments have recently been proposed and one (FRX-C) is now under construction. The proposed experiments are based on recent theoretical advances and experimental results obtained with the LASL FRX-A and FRX-B field-reversed theta-pinch devices. These recent experiments demonstrate a formation method and establish some of the confinement properties for one type of plasma compact torus - an elongated prolate plasma torus confined by purely poloidal magnetic field. The plasma displays a quiescent phase, free of any gross MHD instabilities, that persists much longer than either characteristic MHD times or open-field line loss times. (MOW)

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 10335

HEATING AND FUELING SYSTEMS

REFER ALSO TO CITATION(S) 11006

10998 (UCID—18500) **Nozzle model of flowing plasma with field reversal.** Shearer, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Jan 1980. Contract W-7405-ENG-48. 23p. Dep. NTIS, PC A02/MF A01.

The flowing plasma outflow from a field-reversed plasma gun is modeled by a one-dimensional calculation which is based on the well-known problem of fluid flow through a nozzle. The results suggest that a low plasma mass flow rate is necessary for reconnection to be important. Comparison with 2D MHD calculations and with preliminary data from the BETA-II experiment are consistent with the model at this time.

10999 Investigation of stray particle loss in deflection magnet region of neutral beam line. Kim, J.; Menon, M.M. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **51**: No. 1, 19-21(Jan 1980).

Separation of residual charged particles from neutral particles is typically made by a deflection magnet in a neutral beam injection line for heating fusion plasmas. Ionization of energetic neutrals and neutralization of energetic ions in the deflection magnet region due to collisions with the background gas molecules result in a finite amount of particles that are only partially deflected, which we call a "stray particles loss." Quantitative determination of the stray particle loss has been made from calorimetric data of beam power deposited along a beam line employing a 40-kV 60-A hydrogen ion source. The stray particle loss is typically 3—5% of the accelerator power and roughly proportional to the background gas pressure. A simple calculation is shown to be in fair agreement with the measurements.

INERTIAL CONFINEMENT TECHNOLOGY

11000 (NRL-MR—4132) **Stability of self-similar flow. 6. Uniform implosion of an ablatively driven shell.** Book, D.L.; Bernstein, I.B. (Naval Research Lab., Washington, DC (USA)). 17 Dec 1979. Contract ES-77-A-01-6021. 34p. Dep. NTIS, PC A03/MF A01.

The linear stability of a uniformly imploding shell, modeled as an ideal polytropic fluid, is investigated. Two types of unstable modes are found: incompressible irrotational perturbations localized at the outer surface, ascribable to Rayleigh-Taylor instability, and compressible modes, associated with convective instability. KIDDER's (1976) result for the Rayleigh-Taylor modes is shown to hold independently of the form of the shell density profile. By means of a variational principle it is shown that the criterion for convective instability is the existence of a region within which d(prho$^-$/sup γ/)/dr > 0. Analytic solutions for both spatial and temporal dependence of the perturbations are presented, and the results applied to pellets imploded by the action of a laser or charged-particle beam.

11001 (UCRL—15105) **Liquid metal engineering aspects of a commercial-sized power plant based on the hylife converter concept.** Hoffman, N.J.; McDowell, M.W. (Energy Technology Engineering Center, Canoga Park, CA (USA)). Dec 1979. Contract W-7405-ENG-48. 45p. Dep. NTIS, PC A03/MF A01.

A study of a commercial fusion plant based on the High Yield Lithium Injection Fusion Energy (HYLIFE) converter has been performed. A net efficiency of 33.3% was derived for a plant using 2-1/4 Cr - 1 Mo ferritic steel as structural alloy. Use of a thick lithium fall to protect structural materials from the deleterious effects of pellet thermonuclear burn allows the structure to last the life of the plant without replacement. Both mechanical pumps and EM pumps are analyzed for this application. The power requirement for the lithium fall mechanical pumps is ~ 20 MWe. This is a relatively insignificant 1.6% of the gross electrical power output of the plant of ~ 1250 MWe. An EM pump has a greater electrical requirement but the lesser head (NPSH) requirement of an EM pump appears to be a marked advantage since this affects the size of the lithium inventory. The preferred tritium separation method appears to be that developed by Argonne National Laboratory which involves mixing lithium into an immiscible liquid having a greater affinity for hydrogen isotopes, with subsequent electrolytic separation. The immiscible liquid under consideration is a lithium bromide-lithium fluoride-lithium chloride mixture.

11002 Plasma sheath driven targets. Brownell, J.H.; Freeman, B.L. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87544). *Appl. Phys. Lett.;* **36**: No. 3, 193-194(1 Feb 1980).

Plasma focus driven target implosions are simulated using hydrodynamic-burn codes. Support is given to the idea that the use of a target in a plasma focus should allow "impedance matching" between the fuel and gun, permitting larger fusion yields from a focus-target geometry than the scaling laws for a conventional plasma focus would predict.

11003 Experimentally determined absorption for spherical-shell targets. Segall, S.B. (KMS Fusion, Inc., Ann Arbor, Michigan 48106). *J. Appl. Phys.;* **51**: No. 1, 206-209(Jan 1980).

Energy absorbed by spherical-shell targets irradiated using the KMSF ellipsoidal-mirror illumination system at powers on target of up to 1.0 TW has been measured using a thermopile differential calorimeter. Data are presented for 1.06 and 0.532-μm laser light, for glass and low-atomic-number PVA targets, and for laser configurations with and without a plasma spatial filter.

11004 X-ray measurement of laser fusion targets using least squares fitting. Singleton, R.M.; Weinstein, B.W.; Hendricks, C.D. (University of California, Lawrence Livermore Laboratory, P.O. Box 5508, Livermore, California 94550). *Appl. Opt.;* **18**: No. 24, 4116-4123(15 Dec 1979).

This paper presents an x-ray technique for measurement of opaque hollow microspheres used as laser fusion targets. We describe a nondestructive method for holding microspheres that enables microsphere rotation between x-ray exposures. We record film images of the microspheres using contact microradiography. We use computer image analysis for measurement of the microsphere characteristics, which involves mathematically modeling processes that relate the microsphere characteristics to film density and then applying a least squares fit of the model to the image data. We compared this measurement with the optical interferometric measurement for several glass microspheres and found measurement differences <0.3 μm for wall thickness and 0.1 μm for nonconcentricity.

11005 Monte Carlo (hybrid) suprathermal electron transport. Mason, R.J. (Laser Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev. Lett.;* **43**: No. 24, 1795-1798(10 Dec 1979).

A 1-D hybrid model for electron transport in laser targets is introduced, in which the suprathermal electrons are collisional PIC particles, the thermal electrons are a donor-cell fluid, and the E field is calculated by artificially dilating the plasma period. The scheme shows that resistive E fields are too transient and that a calculated ion-acoustic level is too low to explain experimentally observed reduced transport, that can, however, arise as convective inhibition enhanced by troughs in the target density profile.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

11006 (GA-A—15654) Doublet III vacuum vessel neutral beam armor. Sevier, L.; Davis, L.; Bailey, E.; McKelvey, T.; Smith, R. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract EY-76-C-03-0167-038. 7p. (CONF-791102—77). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

The evolution of the Doublet III neutral beam armor is followed from the initial design of a radiation cooled metallic tile to the present actively cooled graphite design. Results of the thermal and stress analyses that dictated the present design are reviewed.

11007 (GA-A—15659) Fiber-optic high voltage isolation of CAMAC highway. Lee, S.T.; Moore, C.D. (General Atomic Co., San Diego, CA (USA)). Nov 1979. Contract EY-76-C-03-0167-038. 7p. (CONF-791102—78). Dep. NTIS, PC A02/MF A01.

From 8. symposium on engineering problems of fusion research; San Francisco, CA, USA (13 Nov 1979).

Fault analyses of the Doublet III Machine predict that a worst-case 30 kV might accidentally appear on control and data acquisition wiring connected to CAMAC interface systems. Such an accident could cause damage in CAMAC and computer equipment as distant as the control room, with attendant possibility of personal injury to operators and experimenters. Protection for control room personnel and equipment has been provided in the form of fiber-optic data link systems installed in CAMAC parallel branch and byte serial highways. Both fiber-optic data link systems were designed, documented, and fabricated at General Atomic, using vendor-supplied fiber-optic transmitter and receiver modules. (MOW)

GENERAL AND MISCELLANEOUS

MANAGEMENT

11008 (DOE/AD—0010/7) Selected DOE Headquarters publications, October 1979-January 1980. (Department of Energy, Washington, DC (USA). Energy Library). Jan 1980. 26p. Dep. NTIS, PC A03/MF A01.

Beginning with this issue (DOE/AD-0010/7), this publication provides cumulative listings of and an index to DOE headquarters publications issued since October 1979. (Publications issued during October 1977-September 1979 are covered in DOE/AD-0010/6). Three types of headquarters publications are included: publications dealing mainly with program and policy that are attributed to and issued by headquarters organizations, reports prepared by contractors to describe research and development work they have performed for the Department, and environmental development plans and impact statements. Certain publications have been omitted. They include such items as pamphlets, fact sheets, bulletins, newsletters, telephone directories, publications issued under the DOE/tr, CONF, DOE/JPL, and DOE/NASA codes, and weekly/monthly reports of the Energy Information Administration. (RWR)

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 9575, 10444, 10515, 10531

11009 (CONF-780879—) Proceedings of the 6th annual Speakeasy conference. (Argonne National Lab., IL (USA)). 1978. Contract W-31-109-ENG-38. 149p. Dep. NTIS, PC A07/MF A01.

From 6. annual speak easy conference; Chicago, IL, USA (17 Aug 1978).

Portions of document are illegible.

This meeting on the Speakeasy programming language and its applications included papers on the following subjects: graphics (graphics under Speakeasy, Speakeasy on a mini, color graphics), time series (OASIS - a user-oriented system at USDA, writing input-burdened linkules), applications (weather and crop yield analysis system, property investment analysis system), data bases under Speakeasy (relational data base, applications of relational data bases), survey analysis (survey analysis package from Liege, sic and its future under Speakeasy), and new features in Speakeasy (partial differential equations, the Speakeasy compiler and optimization). (RWR)

11010 (COO—3077-159) Progress report No. 55, October 1, 1978-September 30, 1979. (New York Univ., NY (USA). Courant Mathematics and Computing Lab.). 1 Nov 1979. Contract EY-76-C-02-3077. 33p. Dep. NTIS, PC A03/MF A01.

Brief (partial-page) summaries are given of work in the following areas: analytical and numerical methods (applied analysis, computational mathematics, numerical methods for partial differential equations) and advanced computer concepts (software engineering, distributed systems, high-performance systems). Other sections of the report deal with the relation of work done here to other projects, seminars, and publications. (RWR)

11011 (DOE/TIC—11057) Computer-generated illustrations. Johnson, C.K. (Oak Ridge National Lab., TN (USA)). 1979. Contract W-7405-ENG-26. 10p. Dep. NTIS, PC A02/MF A01.

The computer graphics technique is one of the best available methods for analyzing and communicating complex results involving crystallographic structural information. The article starts by pointing out some factors in the visual analysis of technical illustrations. The types of commercial equipment available for use in crystallographic computer graphics and the commitment needed from the user of typical operational configurations are discussed. The Oak Ridge Crystallographic Imaging and Graphics System is given as an example configuration for stepwise interactive graphics and image processing. The applications of computer graphics to crystallography described are density-map representation, particularly by critical-point networks, and the drawing of crystal structures. The various types of line drawings and surface illustrations currently in use are discussed, and two solutions of the hidden-line problem for thermal-ellipsoid drawings are compared.

11012 (ORNL/CSD/TM—79) DGPACK: a collection of subroutines for input/output between an AYDIN CONTROLS 8295 Graphics Display Generator and a MODCOMP II minicomputer. LeBlanc, R.G. (Union Carbide Corp., Oak Ridge, TN (USA). Computer Sciences Div.). Dec 1979. Contract W-7405-ENG-26. 40p. Dep. NTIS, PC A03/MF A01.

A package of FORTRAN-callable subroutines was developed to permit data transfers between a MODCOMP II minicomputer and an Aydin Controls Model 8295 Display Generator. The display

generator is a general-purpose random-scan display processor capable of refreshing up to four different vector graphics displays simultaneously. Display devices available include CRTs and high-intensity video projectors. Three additional FORTRAN subroutines and two sample main programs are described which illustrate the use of the display generator with the DGPACK routines in a simulated pen plotter mode. 1 figure, 1 table.

11013 (ORNL/TM—6993) **SAS graphics procedure: DISPLA1. Environmental Sciences Division Publication No. 1400.** Olson, R.J.; Kumar, K.D. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

The DISPLA1 procedure is a computer program which serves as an interface between the Statistical Analysis System (SAS) and the Display Integrated Software System and Plotting Language (DISSPLA). It allows SAS users to produce high-quality line plots directly from the SAS system. User options include titles, axis labels, line legends, axis scale specifications (linear, logarithmic, or month-labeled), symbol types, line patterns, and plot enhancements. The output is a compressed DISSPLA plot file accessible by the DISSPLA post-processor to generate plots on paper, 35-mm slide film, or graphics cathode ray tube terminals. Procedure options and parameters, including sample plots, are described. 4 figures, 3 tables.

11014 (ORNL/TM—7084) **Sampling theory methodology applicable to data validation studies.** Chernick, M.R. (Oak Ridge National Lab., TN (USA)). Jan 1980. Contract W-7405-ENG-26. 44p. Dep. NTIS, PC A03/MF A01.

In data validation studies, surveys are conducted to obtain information about the data collection process and the uses of the data. In many cases standard sampling techniques can be used. Two methods, stratified random sampling and cluster sampling, were used for surveys in the Form 4 data validation study. Form 4 is a data collection system on monthly generation and consumption of fuels by electric power plants. A description of those applications is given. Sometimes time and cost constraints make more sophisticated controlled sampling approaches necessary. One such approach using balanced incomplete block designs is described; an appendix surveys the existence results for these designs. Sequential methods which may prove to be more cost effective are discussed, as are sequential approaches to the problem of determining the size of a population. Problems requiring further research are also discussed. Some preliminary results on the problem of stratification with respect to more than one variable are included. The results were obtained for the Form 4 respondent population. The Form 4 study indicated that standard statistical sampling methods could be useful in data validation surveys. For example, at least 30 percent of the respondents do not report net generation as the instructions define it, and only 25 percent of the state regulatory agencies use the Form 4 data. Such inferences were possible only because statistical sampling procedures were used. 3 tables.

11015 (SAND—79-8278) **QPLOT: a library of FORTRAN subroutines for quick look data graphing.** Short, H.G. (Sandia Labs., Livermore, CA (USA)). Nov 1979. Contract EY-76-C-04-0789. 23p. Dep. NTIS, PC A02/MF A01.

QPLOT is a set of FORTRAN-compatible data plotting subroutines. Its purpose is to provide a simplified method of data representation for those applications that do not require presentation quality graphics. QPLOT is a stand-alone plot package and does not require knowledge of any other graphics software system. 4 figures.

11016 (SU—326-P3067) **Projected Lagrangian algorithms for nonlinear minimax and l_1 optimization.** Overton, M.L. (Stanford Univ., CA (USA). Dept. of Computer Science). Aug 1979. Contract EY-76-S-03-0326-030. 172p. Dep. NTIS, PC A08/MF A01.

Thesis.

This thesis presents new algorithms for solving the nonlinear minimax and l_1 optimization problems. The minimax problem often arises in circuit design and game theory, while solving the l_1 problem is useful in the robust analysis of experimental data. Both the minimax and l_1 problems are unconstrained optimization problems whose objective functions are not differentiable everywhere, and hence cannot be solved efficiently by standard techniques for unconstrained optimization. The minimax problem can be transformed into a nonlinearly constrained optimization problem with one extra variable, where the objective and constraint functions are continuously differentiable. The algorithm presented exploits the special structure of this equivalent problem. A direction of search is obtained at each iteration of the algorithm by solving an equality-constrained quadratic programing problem, related to one a projected Lagrangian method might use to solve the equivalent constrained optimization problem. Special Lagrange multiplier estimates are used to form an approximation to the Hessian of the Lagrangian function, which appears in the quadratic program. The direction of search is guaranteed to be a descent direction for the minimax objective function. Under mild conditions the algorithms are locally quadratically convergent if analytical Hessians are used. The l_1 problem can also be transformed into a nonlinearly constrained optimization problem, but it involves many extra variables. A method closely related to that for the minimax problem which requires successively solving quadratic programs in the same number of variables as that of the original problem is constructed. Several flexible steplength algorithms are presented, along with algorithms for univariate minimization of the minimax, l_1 and related functions. The usefulness of the methods is illustrated by presenting the results of applying them to a number of problems from the literature. 11 figures, 1 table.

11017 (UCID—17870) **Polynomial evaluation using parallel processing and specialized hardware for scientific applications.** Cox, L.A. Jr.; Bender, C.F.; White, W.; Christoffersen, R.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.; Kansas Univ., Lawrence (USA). Dept. of Chemistry). 1 Jul 1978. Contract W-7405-ENG-48. 22p. Dep. NTIS, PC A02/MF A01.

An algorithm for fast evaluation of polynomials using parallel processing is presented. Feasibility demonstrations at various stages are described, and a timetable for completion within approximately one and one-half years is presented. Implementation of the algorithm will result in increases in speed of polynomial evaluation by approximately a factor of two over conventional linear techniques. By maintaining a modular design, interface to various minicomputer systems and program environments is facilitated.

11018 (UCID—18057) **User's guide to GPDAP: a General Purpose Data Analysis and Plotting Program.** Posehn, M.R.; Fisher, D.K.; Katz, J.G.; Luebke, E.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Feb 1979. Contract W-7405-ENG-48. 106p. Dep. NTIS, PC A06/MF A01.

GPDAP is a General Purpose Data Acquisition and Plotting program for acquisition and reduction of time series data. Data can be acquired directly from a variety of devices ranging in speed from less than one sample/second to one hundred billion samples/second. GPDAP offers data reduction capabilities for both time- and frequency-domain calculations, and provides a variety of data display options including single curve, multiple curve, contour, and 3-D surface plotting. GPDAP is written almost exclusively in FORTRAN IV. It is presently installed on MODCOMP II, III, and IV computers and operates under MODCOMP's MAX II/III and MAX IV operating systems. It is available on several minicomputer systems. 17 figures, 6 tables.

11019 (UCID—18487) **Multigrid methods: an alternate viewpoint.** McCormick, S.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1979. Contract W-7405-ENG-48. 23p. Dep. NTIS, PC A02/MF A01.

Research activity in the numerical solution of elliptic partial differential boundary-value problems is experiencing a revolution of sorts in the form of multigrid methods. Although primitive forms of these methods have actually been known for some time, they have been given very little attention until recently. The new surge of activity is due primarily to the pioneering numerical work of Achi Brandt, who is also extending these methods to apply to problems in such areas as integral equations, optimization, and time-dependent equations. Yet the complexity of these methods has slowed the progress of their dissemination within the technical community. This paper presents an operator-theoretic approach to the multigrid process with the view that the technique is a combined Newton-like method (coarse grid correction) and relaxation scheme (residual smoothing). Attention is focused upon the correction cycle of this process. In this setting, a simplified view of the multigrid processes is provided and some of the nuances of the techniques used in the full multigrid scheme are clarified.

11020 (UCID—30166(Pt.2)) **Computer graphics by example, Part 2. PLOTPK: plotting and analyzing data.** O'Hair, K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 May 1978. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

PLOTPK provides a quick and easy way of plotting data and a flexible means of analyzing it. PLOTPK contains the tools one needs to create two- and three-dimensional graphs and to send them to a TMDS screen, RJET printer, or FR80-generated film. A scientist or engineer can use PLOTPK to scan a volume of data, looking for correlations between parameters and visually validating the data. 9 figures.

11021 **Improved low-discrepancy sequence for multidimensional quasi-Monte Carlo integration.** Braaten, E.; Weller, G. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). EY-76-C-02-0881 COO-881-55. *J. Comput. Phys.;* **33**: No. 2, 249-258(Nov 1979).

We present an improved method of generating vectors for Monte Carlo integration, which produces a significant improvement in rate of convergence over previous methods for problems in more than eight dimensions.

11022 **Multiple positive fixed points of nonlinear operators on ordered Banach spaces.** Leggett, R.W. (Oak Ridge National Lab., TN); Williams, L.R. *Indiana Univ. Math. J.;* **28**: No. 4, 673-688(1979).

The existence of multiple positive fixed points of completely continuous nonlinear operators defined on the cone of an ordered Banach space is considered. The main results give sufficient conditions for such an operator to have two, and in some cases three, positive fixed points. (RWR)

11023 QZ algorithm to solve the generalized eigenvalue problem for complex matrices. Garbow, B.S. (Argonne National Lab., IL). *ACM Trans. Math. Software;* **4**: No. 4, 404-410(Dec 1978).

Three FORTRAN subroutines are provided that implement a complex form of the QZ algorithm for finding λ and z such that Az = λ Bz, where A and B are complex N by N matrices. The complex QZ algorithm is unaffected by singularity or near singularity of B. Subroutie CQZHES implements the first step of the algorithm wherein A and B are simultaneously reduced by unitary transformations to upper Hessenberg and upper triangular form, respectively. Subroutine CQZVAL implements an iterative process that reduces A to upper triangular form while maintaining the trianglar form of B. The eigenvalues are derivable from the corresponding diagonal elements of the reduced A and B. Subroutine CQZVEC applies the accumulated transformations from the two earlier steps onto the eigenvectors of the triangular problem. No facility is provided for obtaining just a few eigenvectors or, for balancing A and B. A long-precision IBM version of the subroutines was tested on a 370/195. There are no machine-dependent constants in the subroutines, so the standard version should run directly on different machines. (RWR)

11024 D-optimal fractions of three-level factorial designs. Mitchell, T.J.; Bayne, C.K. (Union Carbide Corp., Oak Ridge, TN). *Technometrics;* **20**: No. 4, 369-380(Nov 1978).

From 138. annual meeting of the American Statistical Association; San Diego, CA, USA (14 Aug 1978).

D-optimal fractions of three-level factorial designs for p factors are constructed for factorial effects models ($2 \leqq p \leqq 4$) and quadratic response surface models ($2 \leqq p \leqq 5$). These designs are generated by use of an exchange algorithm for maximizing norm X'X and an algorithm which produces D-optimal balanced array designs. The design properties for the DETMAX designs and the balanced array designs are tabulated. An example is given to illustrate the use of such designs. 11 tables.

11025 Lanczos method for a class of nonsymmetric systems of linear equations. Widlund, O. (New York Univ., NY). Contract E(11-1)-3077. *SIAM J. Numer. Anal;* **15**: No. 4, 801-812(Aug 1978).

Let L be a real linear operator with a positive definite symmetric part M. In certain applications a number of problems of the form Mv = g can be solved with less human or computational effort than the original equation Lu = f. An iterative Lanczos method, which requires no information a priori on the spectrum of the operators, is derived for such problems. The convergence of the method is established with the assumption only that $M^{-1}L$ is bounded. If $M^{-1}L$ differs from the identity mapping by a compact operator, the convergence is shown to be superlinear. The method is particularly well suited for large sparse systems arising from elliptic problems. Results from a series of numerical experiments are presented. They indicate that the method is numerically stable and that the number of iterations can be accurately predicted by the error estimate. 1 figure, 1 table.

11026 Some conditions for weak convergence to equilibrium of nonlinear contraction semigroups. Pimbley, G.H. Jr.; Nicolaenko, B. (Los Alamos Scientific Lab., NM). *J. Differ. Equations;* **29**: No. 2, 269-277(Aug 1978).

Let x(t) an element of D(A) be the solution of the following initial-value problem in a real Hilbert space H: x/sub t/ + Ax containing as an element 0, x(0) = f, f an element of D(A). A is a multivalued maximal monotone nonlinear operator. A semigroup T(t) of contractions on D(A)-bar solving the problem exists. What is of interest is whether x(t) = T(t)f converges to a fixed point as $t \to \infty$, and if so, how. The fixed points are exactly those points x/sup */ an element of D(A) such that 0 is an element of Ax/sup */. F is the (non-null) set of fixed points. With this assumption it has been shown that x(t) is bounded. Bruck [J. Funct. Anal., 18: 15-25(1975)] gives a sufficient condition on the operator A for weak convergence of x(t) to an element of x/sup */ is an element of F; this condition is called demipositivity. Demipositive operators as a class are examined, and three types of such operators that might, with benefit, receive special treatment are noted. (RWR)

11027 Class of linked diagrams. I. Enumeration. Stein, P.R. (Los Alamos Scientific Lab., NM). *J. Comb. Theory;* **24**: No. 3, 357-366(May 1978).

Recurrence rules are derived for enumerating the linked diagrams first encountered by Touchard in 1952 [Can. J. Math., 4, 2-25(1952)]. These may be characterized as the subclass of irreducible diagrams in the full set of (2n - 1) double-factorial complete pairings on 2n points. In addition, a recurrence rule is given for the number of symmetric irreducible diagrams. This enables one to calculate the number of symmetry-reduced irreducible diagrams. 7 figures, 1 table.

11028 Time evolution of almost periodic solutions of the KdV equation. Hyman, J.M. (Los Alamos Scientific Lab., NM). Contract E(11-1)-3077. *Rocky Mt. J. Math.;* **8**: No. 1-2, 95-104(Win 1978).

Lax has developed a theory describing a large class of space periodic solutions of the KdV equation which are almost periodic in time [Comm. Pure Appl. Math.; 28: 141-188(1975)]. In this note, an example in this class is numerically constructed and studied. 3 figures.

11029 Computation of discontinuous solutions of linear hyperbolic equations. Mock, M.S. (Rutgers Univ., New Brunswick, NJ); Lax, P.D. Contract EY-76-C-02-3077*000. *Commun. Pure Appl. Math.;* **31**: 423-430(1978).

Let L be a linear hyperbolic operator in any number of variables with C/sup ∞/ coefficients. A solution u of Lu - 0 which has C/sup ∞/ initial data is C/sup ∞/ for all time. Let L/sub h/ be a difference approximation to L that is stable, and accurate of order v. Denote by U the solution of L/sub h/U = 0 the initial values of which agree with those of u on the lattice points, h denoting the mesh width of the lattice. At all times t at which U is available, and in any fixed range $0 \leqq t \leqq T$, the absolute value of (u(t) - U(t)) = O(h/sup v/). Consider piecewise C/sup ∞/ initial data whose discontinuities occur across C/sup ∞/ surfaces. It is known that solutions u of Lu = 0 with such initial data are themselves piecewise C/sup ∞/, and their discontinuities occur across characteristic surfaces issuing from the discontinuity surface of the initial data. What happens when such a solution is approximated by a solution of L/sub h/U = 0 is discussed. It is shown that, for a scheme of any order v, the moments of U approximate those of u with accuracy O(h/sup v/), provided that the initial data of U are pre-processed appropriately near the discontinuities; this is true for equations in any number of variables, and with variable coefficients. It is further shown that post-processing the approximate solution can recover the exact solution, as well as its derivatives, with an error O(h/sup v-δ/, δ as small as desired, at all points, no matter how close to the discontinuity. (RWR)

11030 Numerical solution of nonlinear elliptic partial differential equations by a generalized conjugate gradient method. Concus, P. (Lawrence Berkeley Lab., CA); Golub, G.H.; O'Leary, D.P. *Computing;* **19**: 321-339(1978).

A generalized conjugate gradient method for solving sparse positive-definite systems of linear equations arising from the discretization of elliptic partial-differential boundary-value problems has been studied previously. Here, extensions to the nonlinear case are considered. The original discretized operator is split into the sum of two operators, one of which corresponds to a more easily solvable system of equations, and the associated iteration based on this splitting is accelerated by (nonlinear) conjugate gradients. The behavior of the method is illustrated for the minimal surface equation with splittings corresponding to nonlinear SSOR, to approximate factorization of the Jacobian matrix, and to elliptic operators suitable for use with fast direct methods. The results of numerical experiments are given as well for a mildly nonlinear example, for which, in the corresponding linear case, the finite termination property of the conjugate gradient algorithm is crucial. 4 tables.

INFORMATION HANDLING

REFER ALSO TO CITATION(S) 9839, 9840

11031 (DOE/TIC—7000(Rev.4)) Energy information data base: subject thesaurus. (Department of Energy, Oak Ridge, TN (USA). Technical Information Center). Oct 1979. 857p. Dep. NTIS, PC A99/MF A01.

The technical staff of the DOE Technical Information Center, during its subject indexing activities, develops and structures a vocabulary that allows consistent machine storage and retrieval of information necessary to the accomplishment of the DOE mission. This thesaurus incorporates that structured vocabulary. The terminology of this thesaurus is used for the subject control of information announced in DOE Energy Research Abstracts, Energy Abstracts for Policy Analysis, Solar Energy Update, Geothermal Energy Update, Fossil Energy Update, Fusion Energy Update, and Energy Conservation Update. This terminology also facilitates subject searching of the DOE energy information data base, a research in progress data base, a general and practical energy information data base, power reactor docket information data base, nuclear science abstracts data base, and the federal energy information data base on the DOE on-line retrieval system, RECON. The rapid expansion of the DOE's activities will result in a concomitant thesaurus expansion as information relating to new activities is indexed. Only the terms used in the indexing of documents at the Technical Information Center to date are included. (RWR)

CIVILIAN DEFENSE

11032 Availability and shipment of grain for survival of a nuclear attack. Haaland, C.M. (Oak Ridge National Lab., TN). *Am. J. Agric. Econ.;* **59**: No. 2, 358-369(May 1977).

It is assumed that at least 90% of the American population would survive the direct effects (blast, fire, and initial nuclear radiation) of a nuclear attack of 6600 megatons if about 90 million people were relocated from high-risk areas during a crisis period preceding the attack. If the survivors from the direct effects are protected from radioactive fallout by suitable shelters, the remaining major problem affecting survival will be adequate food. This paper indicates that sufficient grain stocks and transportation will likely be available after the attack to assure survival of the American population.

CORPORATE INDEX

In the Corporate Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the report title and the volume and abstract numbers. Report numbers, if applicable, are given in parentheses at the end of the entry.

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The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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7	5:10755	*See* COO-3064-036
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1	5:10809	Dep. NTIS, PC A02/MF A01
CONF-790774-		(SLAC summer institute on particle physics: quantum chromodynamics, Stanford, CA, USA, 9-20 Jul 1979)
2	5:10793	*See* SLAC-PUB-2402
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84	5:10139	*See* GA-A-15556
85	5:10138	*See* GA-A-15551
CONF-790843-		(8. international conference on atomic collisions in solids, Hamilton, Canada, 13-17 Aug 1979)
13(Draft)	5:10713	Dep. NTIS, PC A02/MF A01
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14	5:10885	Dep. NTIS, PC A03/MF A01
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6	5:10778	*See* ANL-HEP-CP-79-36
12	5:10473	*See* SLAC-PUB-2425
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1	5:10761	*See* UH-511-364-79
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7	5:10870	Dep. NTIS, PC A02/MF A01
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1	5:10869	Dep. NTIS, PC A03/MF A01
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2	5:10491	*See* Y/DW-2
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1	5:10411	*See* RHO-SA-122
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CONF-791009-		(International conference on energy use management, Los Angeles, CA, USA, 22-26 Oct 1979)
24	5:9958	*See* LBL-9370
CONF-791022-		(4. national passive solar energy conference, Kansas City, KS, USA, 3-5 Oct 1979)
11	5:9980	*See* LBL-9295

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18	5:10475	Dep. NTIS, PC A02/MF A01
19	5:10488	*See* BNL-26850
20	5:10485	*See* BNL-26862
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24	5:10409	*See* K/TL-865
CONF-791058-	(International conference on nuclear cross sections for technology, Knoxville, TN, USA, 22-26 Oct 1979)	
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63	5:10922	*See* BNL-26916
64	5:10899	Dep. NTIS, PC A02/MF A01
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4	5:10669	Dep. NTIS, PC A03/MF A01
CONF-791090-	(Symposium on potential environmental and health effects of atmospheric sulfur deposition, Gatlinburg, TN, USA, 14-18 Oct 1979)	
3	5:10681	*See* BNL-26971
CONF-7910104-	(4. United States gulf coast geopressured-geothermal energy conference, Austin, TX, USA, 29-31 Oct 1979)	
1	5:9663	Chicago, IL; Institute of Gas Technology, Chicago, IL (1979).
2	5:9664	Chicago, IL; Institute of Gas Technology, Chicago, IL (1979).
CONF-7910105-	(2. world energy engineering conference, Atlanta, GA, USA, 28-31 Oct 1979)	
1	5:10246	Inst. of Gas Technology, Chicago, IL
2	5:9747	Dep. NTIS, PC A02/MF A01
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1	5:10757	*See* SLAC-PUB-2429
2	5:10818	*See* SLAC-PUB-2436
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1	5:10471	Dep. NTIS, PC A02/MF A01
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1	5:10691	*See* DP-MS-79-46
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77	5:11006	*See* GA-A-15654
78	5:11007	*See* GA-A-15659
83	5:10341	*See* BNL-26950
85	5:10468	*See* BNL-26894
86	5:10335	*See* BNL-26989
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51	5:9703	*See* DP-MS-79-55
64	5:10141	*See* HEDL-SA-1868
CONF-791108-	(72. AICHE meeting, San Francisco, CA, USA, 25-29 Nov 1979)	
12	5:9578	Chicago, IL; Institute of Gas Technology, Chicago, IL (1979).
13	5:9707	*See* K/ET-174
CONF-791112-	(Symposium on the scientific basis for nuclear waste management, Boston, MA, USA, 26-29 Nov 1979)	
46	5:9713	*See* DP-MS-79-30
CONF-791117-	(ANS topical conference, Kiawah Island, SC, USA, 26-19 Nov 1979)	
19	5:9738	*See* SAND-79-1046C
CONF-791131-	(Joint meeting of AICHE, ASME, and IEEE, Paducah, KY, USA, 13 Nov 1979)	
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15	5:10469	*See* BNL-26951
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3	5:10342	*See* LA-UR-79-3509
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2	5:10886	Dep. NTIS, PC A02/MF A01
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1	5:9963	*See* UCRL-83458
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3	5:9809	*See* SAND-79-2445C
5	5:9783	*See* DOE/NASA/20485-79/6
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2	5:10243	*See* LBL-8394
CONF-800208-	(Tropical meeting on inertial confinement fusion, San Diego, CA, USA, 26-28 Feb 1980)	
3	5:10472	*See* SAND-79-1945C
CONF-800303-	(179. national meeting of the American Chemical Society, Houston, TX, USA, 23-28 Mar 1980)	
3	5:9692	*See* RFP-3036
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2	5:10927	*See* SLAC-PUB-2441
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24159	5:9787	Sacramento, CA; California Energy Commission (1979).
24207(Vol.1)	5:9603	Washington, DC; Bureau of Land Management (1979).
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24223	5:10602	Gainesville, FL; University of Florida (1979).
24247	5:10208	EPRI, Palo Alto, CA
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6342	5:10482	Dep. NTIS, PC A08/MF A01
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6993	5:11013	Dep. NTIS, PC A03/MF A01
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292891	5:9785	NTIS PCA09/MF A01
292893	5:10531	Source tape is in EBCDIC character set. Character set restricts preparation to 9 track one-half inch tape only. Identify recording mode by specifying density only. Call NTIS Computer Products if you have questions. Price includes documentation, PB-286 285.
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292947	5:10563	NTIS PCA08/MF A01
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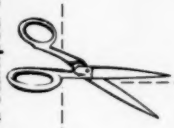

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